SUGARBEET RESEARCH

1978 REPORT

A Report to and for
the Sole Use of Cooperators

NOT FOR PUBLICATION

F O R E W O R D

SUGARBEET RESEARCH is an annual compilation of progress reports concerning incomplete research by Science and Education Administration investigators and cooperators who are engaged in sugarbeet variety and production research. The report has been assembled by Dr. John S. McFarlane, Technical Advisor for sugarbeet breeding. The report has been reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor or contributors.

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Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

CONTENTS

CONTENTS

SUGARBEET RESEARCH

1978 Report

Section A

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Cooperation:

American Crystal Sugar Company
Holly Sugar Corporation
Spreckels Sugar Division
Union Sugar Division
California Beet Growers Association

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CONTENTS

SUMMARY OF ACCOMPLISHMENTS, 1978

RESISTANCE TO BEET WESTERN YELLOWS--In 1977 the virus yellows resistance breeding program was modified so that germplasm selections and evaluations were made against BWYV infection and not the BYV-BWYV complex as previously done. This modification was made for several reasons: (1) BYV was being well controlled culturally by the rigid adherence to beet-free periods; (2) BWYV which is poorly controlled by beet-free periods or most existing cultural practices remained a common malady in commercial production of beets; and (3) when both BYV and BWYV were used for inoculum, the more severe BYV mask many of the effects of BWYV and little was actually known about the damage potential of western yellows, the extent of host-plant resistance, the importance of resistance to western yellows in existing resistant germplasm and cultivars, or of possible host-parasite interactions. In order to confirm and expand the knowledge obtained from the 1977 tests, the 1978 yellows tests were in part a repetition of these 1977 evaluations. The 1978 variety x BWYV tests are summarized in Tests 1378, 1478, and 1578 (pages A28 - A33).

The reaction of breeding lines and hybrids evaluated in 1978 ranged from about 5% loss for C17 to about 37% sugar yield loss for SP6822-0. As in 1977, host reactions to yellows as measured by sugar yield losses are highly variable with test CV's in excess of 30% and the need for LSD (.05) values to be greater than 5% loss. Scores based on severity of yellows symptoms 6 to 8 weeks after inoculation gave reasonably good estimates of host reactions. Even though considered susceptible, breeding lines or hybrids with a long history of development in California, e.g., US 75 (468), F66-64, F70-546H3, and US H7, are significantly less susceptible than several entries developed away from natural exposure to BWYV, e.g., SP6822-0 and US H20. On the other extreme, C17 and closely related lines, e.g., E737, show very mild symptoms and sustain relatively little loss. However, for all entries, these loss data are probably biased downward due to infection in the noninoculated checks (as was the case for the 1978 tests). These biases are probably particularly true for the susceptible entries. By the same token, the yield data presented for the noninoculated portion of these tests are probably biased in favor of the more yellows resistant entries. If infection could be prevented in the checks, it is visualized that the measured sugar yield losses due to BWYV infection in the most susceptible entries might approach 50%. These tests thus demonstrated that BWYV has great potential for reducing sugar yield in susceptible cultivars but that sufficient host-plant resistance is available to greatly reduce this vulnerability. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

RESELECTION IN O.P. VARIETIES FOR RESISTANCE TO VIRUS YELLOWS--The data in Table 1478 show the performance for yield and BWYV reaction for some of the O.P. lines being carried in the virus yellows resistance program. As can be noted, these breeding lines are somewhat different for yield performance and reaction to BWYV. Of special interest is the comparison between the entries designated Y730 and 468. Line 468 is an increase of the obsolete O.P. cultivar US 75 from which the current pollinators C13, C17, and C36 were derived. Line Y730 represents the sixth cycle of mass selection from BYV-BWYV inoculated, spaced plants of US 75. Although both Y730 and the C13 to C17 series started with US 75, they represent different selection programs.

During the selection of C13, as few as five plants survived one cycle of selection and other cycles had as few as 11 participants. Because this led to a narrowed base of virus yellows resistant germplasm, it seemed desirable to reselect from US 75 and to try to maintain a broader germplasm base. Of great interest also was a general re-evaluation of the mass selection procedure for identifying yellows resistant genotypes and for improving this population for yield performance in comparison to what had been already accomplished by the selection of C13. This reselection also was to serve as a check to determine the comparative progress in a number of other O.P. sources simultaneously being selected for yellows resistance. The results of the reselection from US 75 are summarized very briefly below:

	Sugar Yield (lbs/A)			Beet Yield (T/A)		% Sucrose	
	Check	BWYV	% Loss	Check	BWYV	Check	BWYV
Y730	14,300	12,540	12.2	43.9	40.0	16.3	15.7
468	12,290	9,450	23.0	38.9	31.5	15.8	15.0
	**	**	**	**	**	NS	*

After six cycles of selection, the BWYV reaction of Y730 is approaching the reaction of the lines derived from C13, e.g., F77-36. These C13 derived lines represent an equal number of selections for yellows resistance as Y730. The decrease in loss to yellows has apparently been accomplished in very small increments (averaging about 2%/cycle of selection). The performance of the Y730 line has been significantly improved over that of 468 (US 75) and is equal or better than that of the C13 to C17 series under both noninoculated and inoculated conditions. Experimental hybrids with Y730 have been made and will be evaluated in 1979. These hybrid evaluations should indicate whether simultaneous improvements in Y730 have been achieved for combining ability and give a general appraisal of the ability of mass selection to improve combining ability. A parallel series of selections for yellows resistance were made in the O.P. varieties US 15 and US 56/2. The data in Table 1478 suggest that the selection Y726 derived from US 56/2 is now moderately yellows resistant (10.9% sugar yield loss) whereas Y723 derived from US 15 has remained quite susceptible (25.5% loss). R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

PREDICTION OF REACTION TO BWYV--Three pollinators and two females with different levels of resistance to BWYV and their six possible hybrids were evaluated for reaction to BWYV (Test 1378). As demonstrated by the data extracted from Test 1378 and presented below, the reaction of a hybrid to BWYV (% sugar yield loss) appears to be essentially intermediate to the reaction of the two parents:

Entry	Description	% Sugar Yield Loss Observed	(M + F)/2
C17	Pollinator of US H10	10.6	
C64	" " US H7	23.9	
546H3	Female of US H10 & 7	16.9	
US H10	546H3 x C17	13.8	13.7
US H7	546H3 x C64	22.1	20.4
LSD (.05)		5.2	

This same relationship also was observed in advanced generations of lines derived from two parents with different reactions as these data from Test 1478 show:

Line	Description	% Sugar Yield Loss	
		Observed	$(P_1 + P_2)/2$
C17		4.9	
C01		6.9	
C64		21.9	
Y740	3rd Inc. (C64 x C17)	15.3	13.4
Y741	3rd Inc. (C64 x C01)	15.0	14.4
LSD (.05)		8.1	

The reaction to BWYV thus appears to be transmitted in an additive manner and the reaction of a hybrid can be predicted if the reactions of the individual parental components are known. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

COMBINING ABILITY EVALUATION OF INBRED LINES--In an evaluation of the relationship between single-cross and 3-way cross performance for sugar yield, it was found that the mean performance of 3-way crosses usually was not different from expectations based on the means of single crosses (pages A37 - A39). These tests did not indicate that epistasis was important in the lines tested. Thus, a test of inbreds for general combining ability should accurately predict their performance in various hybrid combinations. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

POPULATION IMPROVEMENT OF MONOGERM GERMPLASM--A comprehensive breeding program in which hybrid varieties are the end product requires that breeding populations with genetic variability be developed and that these populations be improved by effective selection programs. At Salinas, the breeding sources have more or less diverged into those that are self-fertile monogerms and those that are self-sterile multigerms. Population improvement, usually by mass selection, in the self-sterile, multigerm sources has been effective as demonstrated by the development of disease resistant pollinators, e.g., C17, C36, C31, etc. However, population improvement within the self-fertile monogerm sources has proven more difficult, partially because of the lack of random-mating between cycles of selection. To overcome this constraint, a number of monogerm, self-fertile, near-type-O, random-mating populations have been developed by incorporating the gene for genetic male sterility (*a1a1*). Consequently, population improvement is now feasible within the self-fertile, monogerm sources without the continued necessity to outcross to the more advanced self-sterile multigerm sources. In addition, it may be easier to develop and maintain greater genetic diversity between these germplasms than previously possible. Tests 278, 1078, 1378, 1578, 1778, and B678 summarize the results of field tests used to evaluate some of these self-fertile, monogerm random-mating populations. To this time, the improvement within these monogerm populations has been primarily by mass selection for combinations of adaption, disease resistance (virus yellows, *Erwinia*, etc.), and sugar yield as well as for improved type-O and monogerm types. In a test (1578) inoculated with BWYV, several previously selected populations have

shown yellows resistance better than F70-546H3 and approaching that of C36. Populations selected for resistance to Erwinia soft rot were also significantly improved for soft rot resistance. Though by and large susceptible to powdery mildew, individual plants have shown desirable levels of resistance and a first cycle of greenhouse selection has been completed. In comparison with US H10B (Tests 1078, 1378, and B678), some combinations between CMS equivalents of improved random-mating populations and multigerm pollinators have produced hybrids with equal or better sugar yield. Although improved monogerm populations may not be directly useful for commercial hybrid production, these results suggest that parental lines with improved combinations of multiple disease resistance and combining ability can be extracted from these sources. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

COMPARISON OF S_1 AND TESTCROSS EVALUATION AFTER ONE CYCLE OF SELECTION IN SUGARBEET--Synthetics derived from a monogerm, self-fertile, random-mating population were compared in field trials to determine the efficacy of S_1 and test-cross (TX) evaluation procedures at discriminating S_0 genotypes for high and low sugar yield (SY) and % sucrose (pages A52 - A61). As compared to a corresponding but unimproved synthetic, the evaluation of S_1 families successfully identified both higher and lower performing genotypes for the traits in question. Significant changes of 11.3% and -9.8% for SY and 4.2% and -4.0% for % sucrose were obtained. The changes in performance were less in the corresponding synthetics produced on the basis of TX performance. Mass selection for increased SY was as effective as S_1 and TX selection as measured by the performance of the synthetics but was less effective at identifying S_0 genotypes with improved GCA for SY in hybrid combinations. After one cycle of selection, it appeared that S_1 evaluation was superior to TX evaluation for discriminating differences in S_0 plants for GCA as measured in test hybrids with the synthetics. R. T. Lewellen and I. O. Skoyen.

RESISTANCE TO ERWINIA--A breeding program to select for resistance to Erwinia soft rot was continued in 1978. The first, second, or third cycles of selection were made in a number of breeding lines. In addition, approximately 200 breeding lines, parents, and hybrids were evaluated in three injury-inoculated tests. The Erwinia resistance program is summarized on pages A62 - A68 of this report. Results from this program showed that a broad germplasm base is being successfully converted to a significantly higher level of resistance. R. T. Lewellen, E. D. Whitney, and I. O. Skoyen.

FUSARIUM STALK BLIGHT RESISTANCE--Seed increases were made of 25 stalk blight resistant selections from a backcross of the susceptible C563 inbred to the moderately resistant NB1 inbred. Resistant segregates were also found within the C563 inbred. A resistant CMS line from a cross between NB1 CMS and C563 will be used to produce CMS equivalents of the resistant inbreds. A group of 35 lines were evaluated at Salem, Oregon in 1978. Stalk blight ratings ranged from 0 for two of the resistant selections to 3.6 for the susceptible 5564 monogerm inbred (0 = no disease to 4 = dead plant). J. S. McFarlane.

GERMPLASM PRESERVATION--Seed samples of all wild Beta species maintained by SEA sugarbeet researchers were assembled at Salinas and catalogued. Seed increases were made of most seedlots in the Vulgares section. A wild species nursery was grown and descriptions were recorded for each representative of the various species. J. S. McFarlane.

INTERSPECIFIC HYBRIDIZATION STUDIES--Transmission rate of nematode resistant factor from the alien monosomic addition lines of sugarbeet was low in all instances. Most of the progeny with resistance contained 19 chromosomes, with an average frequency of 10.52% through ovule and 0.025% through pollen. Diploid nematode resistant progeny were isolated only at 0.046% frequency. Nematode resistance transmission rates of the progeny of selection 51501 varied from 5.3% to 21.4%, but the overall transmission rate remained the same as that of the parent, i.e., 13.3%. Both the resistant and susceptible progenies were found to have a similar category of meiotic chromosomal abnormalities, which indicated that transmission of nematode resistance could be independent from the bridge formation mechanisms. From the triploid progeny with the resistance, selection 61202, seedlings with chromosome numbers of 18, 19, 20, 26, and 27 have been obtained. None of these single chromosome number groups were completely resistant to cyst nematode. M. H. Yu.

FIELD EVALUATION OF ROOT TOUGHNESS (ROOT FIBER CONTENT)--Two year's data on root toughness in representative breeding lines and varieties have shown that environmental influences are significant. The mean toughness probe value was 20.1 foot pounds pressure in 1977 compared with 1978 values of 22.5 in Test 1 and 23.2 in Test 2, respectively. Significant differences between and within varieties were again observed in 1978. Root selections for both high and low fiber content based on probe values were made in a test seeded in May 1978. I. O. Skoyen and R. T. Lewellen.

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1978

DUFFUS, JAMES E. Beet free periods holds beet yellowing viruses in check. The Sugar Producer 4(1):10-15. 1978.

The yellowing virus diseases are serious hazards to stable production of beet and numerous other crops throughout the world. Since the dawn of agriculture, man has accepted these diseases as being induced by natural factors such as early ripening, drought, excessive moisture, nutritional deficiencies, or soil conditions. The implementation of beet free periods in California beet growing districts since 1968 has dramatically increased sugar production.

DUFFUS, J. E. Legume yellows virus, a new persistent aphid-transmitted virus of legumes from California. Phytopathology (In press). 1979.

Legume yellows virus, a recently discovered virus, which has host range and vector characteristics similar to pea leaf roll virus (PeLRV) and other legume yellowing viruses, has been found to be widespread in California legumes. It is transmitted in a persistent manner by Acyrthosiphon pisum and A. solani to a large number of leguminous species including Pisum sativum, Trifolium incarnatum, T. subterraneum, Vicia faba, Cicer arietinum, Medica[illegible] sativa, and Glycine max, but not to over 30 species in 13 nonleguminous [illegible]ilies tested. Purified preparations proved to be infectious when fed [illegible]phids through membranes and contained mono-disperse icosahedral partic[illegible] approximately 25 nm in diameter. The virus is not identical to other l[illegible]e infecting yellowing viruses such as PeLRV or subterranean clover red leaf v[illegible]uses (SCRLV), but would appear to be very similar. The virus differs markedly from beet western yellows virus (BWYV) in host range and vector specificity but was shown to be closely related in reciprocal infectivity neutralization tests.

DUFFUS, JAMES E. Beet yellow stunt virus. CMI/AAB. Descriptions of Plant Viruses (In press). 1979.

Beet yellow stunt, a potentially destructive yellows-type virus disease of sugarbeet and lettuce, is recognized as being distinct from other yellowing diseases affecting these crops. Sowthistle is the principal reservoir host of the virus and of the most efficient vector, Nasonovia lactucae. The disease is widespread and abundant on this host in California throughout the year. Spread in susceptible crops tends to be marginal; i.e., the disease incidence is high in rows adjacent to areas where sowthistle is prevalent, but becomes progressively less with increased distance from the virus source. Host range of the virus seems limited, but it can induce serious damage to infected sugar beet and lettuce. The virus has not been transmitted mechanically or by seed, but is transmitted in a semipersistent manner by N. lactucae, Myzus persicae, and Macrosiphum euphorbiae.

DUFFUS, JAMES E. Curly top virus control. Proc. IX International Congress of Plant Protection (In press). 1979. (Abstract)

Beet curly top virtually destroyed the sugar beet industry in the western United States following World War I. The disease was the principal limiting factor to sugarbeet production from the early 1900's until World War II. Curly top has been held to less than catastrophic proportions by a complex

control program involving a number of facets of agriculture and which includes the use of: 1) cultivars resistant to the virus; 2) cultural practices to delay infection; 3) vector control in the crop; 4) vector control in non-crop production areas; 5) reduction in leafhopper breeding areas; 6) and reduction in virus sources. In spite of the effective reduction of economic losses induced by curly top over the past several years, the disease is still present and changing along with the ecology of the California production areas. These changes demand constant attention to the present control procedures as well as to future ones.

DUFFUS, J. E. and G. M. MILBRATH. Natural occurrence and distribution of beet western yellows virus in soybean. Amer. Phytopath. Soc. Phytopath. News 12:170. 1978.

In an earlier report, it was established that soybeans, (Glycine max) were susceptible to beet western yellows virus (BWYV). To determine if BWYV is of potential economic significance in midwestern and southern soybean production areas fields and demonstration plots of susceptible soybean cultivars were sampled and indexed for the natural occurrence of BWYV. Positive recoveries were obtained from soybeans and/or other susceptible hosts in Illinois, Indiana, Michigan, Mississippi, Texas, and Wisconsin. Infected plants were chlorotic with yellowing symptoms or in other cases symptomless. The legume isolates of BWYV were similar to sugarbeet and crucifer isolates when tested by infectivity neutralization, ELISA serology and host range. The distribution of BWYV and other serologically related viruses in diverse economic crops raises the possibility that new serotypes adapt to new plant hosts. This is the first report of the natural occurrence of BWYV in legumes in North America.

ESAU, KATHERINE and LYNN L. HOEFERT. Hyperplastic phloem in sugarbeet leaves infected with the beet curly top virus. Amer. J. Bot. 65(7):772-783. 1978.

Electron microscopy of sugarbeet leaves infected with the beet curly top virus confirmed earlier findings by light microscopy that the hyperplastic phloem consists mainly of sieve elements that are more or less abnormal in structure. Some parenchyma cells and occasional companion cells may be present. The hyperplastic phloem develops in the place of normal phloem and sometimes in the adjacent ground tissue and the xylem. The sieve elements vary in shape and may be haphazardly arranged. The protoplasts of the sieve elements have the usual characteristics of this type of cell. The sieve element plastids develop from chloroplasts if the hyperplasia occurs in chloroplast-containing parenchyma cells. The cell walls have sieve areas that often are less well differentiated than those of normal sieve elements. The hyperplastic growth in the phloem of curly top diseased plants is discussed with reference to plant tumors induced by certain other plant viruses.

FALK, B. W., J. E. DUFFUS, and T. J. MORRIS. Genomic masking responsible for dependent aphid transmission of a virus in association with BWYV. Amer. Phytopath. Soc. Phytopath. News 12:194-195. 1978.

Lettuce speckles mottle virus (LSMV) is a mechanically transmissible, unstable plant virus. LSMV has been found in mixed infections with beet western yellows virus (BWYV) in lettuce, sugarbeets and spinach. When in the mixed infection, LSMV is transmissible by the green peach aphid, Myzus persicae Sulz.,

in a persistent, circulative manner. It has been demonstrated that mechanically transmitted LSMV has a very short longevity in vitro, is susceptible to low concentrations of ribonuclease A, and is very efficiently transmitted after phenol extraction of infected tissue. These characters are typical of unstable viruses. When in the mixed infection with BWYV, LSMV become aphid transmissible, is somewhat more stable and exhibits the serological (coat protein) properties of BWYV. In addition, the aphid transmitted LSMV from the mixed infection has a much wider host range than mechanically transmitted LSMV. These data suggest that LSMV is a member of a naturally occurring, previously unrecognized, group of plant viruses that survive and are dispersed in nature as a result of the genomic masking phenomenon.

FALK, B. W., T. J. MORRIS, and J. E. DUFFUS. Lettuce speckles mottle virus - evidence for the presence of replicative structures. Amer. Phytopath. Soc. Phytopath. News 12:148. 1978.

Lettuce speckles mottle virus (LSMV) has many properties similar to those reported for the carrot mottle group. It is unstable, possessing a short longevity in vitro, is highly susceptible to ribonuclease A, and is very efficiently transmitted from phenol extracted tissue. Particles similar to carrot mottle virus (50-70 nm membrane-bound spheres) were observed in cell vacuoles when infected tissues were examined with the electron microscope. Attempts to purify LSMV revealed that a gentle method of purification, consisting only of clarification with bentonite and differential centrifugation, was necessary to preserve infectivity. However, bentonite clarified preparations contained largely LSMV specific double-stranded RNA (ds-RNA) of 2.7×10^6 daltons which was only infectious upon melting. LSMV infectivity resides predominantly with single-stranded RNA. A LSMV specific ss-RNA with an apparent molecular weight of 1.4×10^6 daltons was also isolated from the infectious preparations and is believed to be the infectious viral nucleic acid. These results suggest isolation of a replication structure from LSMV infected tissue. Due to the similarity of the 50-70 nm spherical particles to replication structures for other viruses it is proposed that for LSMV these structures are not virus particles but may be sites of LSMV replication.

FALK, B. W., J. E. DUFFUS, and T. J. MORRIS. Transmission, host range and serological properties of the viruses causing lettuce speckles disease. Phytopathology (In press). 1979.

The speckles disease is caused by a virus complex affecting lettuce, sugarbeets, and spinach in the Salinas and Pajaro Valleys of California. The complex consists of two viruses, beet western yellows virus (BWYV) and lettuce speckles mottle virus (LSMV). Both viruses are transmitted by Myzus persicae, the green peach aphid, in a persistent manner; however, LSMV is only aphid transmissible when in a mixed infection with BWYV. The LSMV is mechanically transmissible and when separated from BWYV by mechanical transmission it loses its aphid transmission character. The host range of LSMV is expanded when it is transmitted by aphids from mixed infections as compared to mechanical inoculation. Lettuce speckles mottle virus exhibits a serological relationship to BWYV when in mixed infections, and the stability of LSMV in vitro is increased in sap from speckles virus complex infected plants as compared to those only infected with LSMV. These data suggest that genomic masking of LSMV by BWYV coat protein occurs as result of the mixed infection.

FALK, B. W., T. J. MORRIS, and J. E. DUFFUS. Unstable infectivity and possible replicative structures associated with lettuce speckles mottle virus. Virology (In press). 1979.

Lettuce speckles mottle virus (LSMV) is an unstable virus, susceptible to short periods of aging in vitro and low concentrations of RNase. Infected leaves extracted using phenol yielded greater infectivity than comparable tissue extracted with buffer. No typical virus particles were observed in infected tissues or semi-purified preparations, but 50-70 nm spherical membranous particles were observed associated with the tonoplast in vacuoles of infected cells. Necleic acid analysis using polyacrylamide gel electrophoresis of infected tissue and LSMV semi-purified preparations revealed abundant double-stranded RNA (ds-RNA) in both preparations. In addition to ds-RNA, a species of disease specific single-stranded RNA (ss-RNA) was isolated from the LSMV semi-purified preparations. LSMV infectivity was associated with the ss-RNA fraction, however, the ds-RNA yielded infectious LSMV upon melting in dimethylsulfoxide. Quantitative isolation of ds-RNA from whole tissue and semi-purified preparations showed the majority of the ds-RNA to be recovered from the semi-purified fractions. Sucrose and cesium chloride density gradient centrifugation suggested that the ds-RNA was associated with a relatively small structure of a low buoyant density.

HURT, LESLIE C., ROBERT D. BARRY, and JOHN S. MCFARLANE. USSR Sugar - Today and tomorrow. Foreign Agricultural Service, USDA, FAS M-284, 15 pages. 1978.

This publication focuses on the economic and institutional features of the Soviet sugar industry. It is based on a trip to the Soviet Union in October 1977 by a United States Department of Agriculture Sugar Beet and Sugar Team. The trip was taken under the U.S.-USSR agreement for exchange of information, and was the first visit of an economic sugar team from the United States to the Soviet Union. The members of the team were Leslie C. Hurt, team leader, Foreign Agricultural Service; Robert D. Barry, Economics, Statistics, and Cooperatives Service; (formerly Economic Research Service) and John S. McFarlane, Science and Education Administration--Agricultural Research (formerly Agricultural Research Service).

The trip was made during the period October 10-28, 1977. The itinerary included Moscow, Kiev, Voronezh, Kishinev, Krasnodar, and producing areas in the Ukraine, Russian Soviet Federated Socialist Republic (RSFSR), and Moldavia. Meetings were held with officials of the Ministry of Agriculture, Ministry of Food and Industry, and Prodintorg (the State Trading Organization). Various collective and state farms and processing plants were visited.

LEWELLEN, R. T., J. S. MCFARLANE, and I. O. SKOYEN. Registration of 11 germplasm lines of sugarbeet. Crop Sci. 18:1100-1101. 1978.

The 11 breeding lines C01, C31, C04, C22, C10, C718, C718 CMS, C705, C705 CMS, C706, and C706 CMS are described.

LEWELLEN, R. T., I. O. SKOYEN, and J. S. MCFARLANE. Registration of three sugarbeet germplasm lines. Crop Sci. 18:1099-1100. 1978.

The three germplasm lines C773, C789, and C789 are described.

LEWELLEN, R. T., I. O. SKOYEN, J. S. MCFARLANE, and E. D. WHITNEY. Release of sugarbeet germplasm combining multiple-disease resistance. USDA-SEA-AR, July 6, 1978.

Eight germplasm lines of sugarbeet were released to sugarbeet breeders as sources of resistance to virus yellows, beet mosaic, curly top, powdery mildew, and Erwinia soft rot. These lines were designated as C779, C779 CMS, C16, C16 CMS, C19, C19 CMS, C43, and C32.

MCFARLANE, JOHN S. Sugarbeet variety development. California Sugar Beet Annual Report, pg. 36-38. 1979.

This popular article traces the history of variety development, discusses sugarbeet breeding methods, and describes the attributes of our present USDA developed varieties.

MILBRATH, G. M. and J. E. DUFFUS. Solanum yellows virus, an apparently distinct member of the luteovirus group. Amer. Phytopath. Soc. Phytopath. News 12:170. 1978.

A yellowing type virus, referred to as Solanum yellows virus (SYV), was isolated from naturally infected Solanum carolinense. It is transmitted in a persistent manner by Myzus persicae, but not Acyrthosiphon pisum. It appears distinct from other luteoviruses in its affinity to the Solanaceae and its yellowing type symptoms on susceptible hosts. In addition to S. carolinense the virus has been transmitted to and recovered from Datura metel, Nicandra physalodes, Nicotiana clevelandii, N. rustica, Physalis floridana and P. wrightii. Of over 40 non-solanaceous hosts tested none have been susceptible. SYV was purified from infected N. clevelandii leaf and stem tissue. The virus sedimented at the same rate in density gradients as the ST-1 strain of beet western yellows virus (BWYV). Preparations from the opalescent zone contained icosahedrons of the same size as BWYV. Neutralization of infectivity and ELISA serological tests with antisera to BWYV, and the RPV strain of BYDV demonstrated that SYV is related to these viruses. Based on this evidence, SYV appears to be a distinct naturally occurring yellowing virus. Its importance and distribution are unknown. The natural occurrence of luteoviruses in diverse plant species has raised questions about potential virus interactions as well as epidemiological considerations.

WHITNEY, E. D. and R. T. LEWELLEN. Registration of two sugarbeet parental lines. Crop Sci. 18:920. 1978.

Two parental lines, C02 and C36, with high levels of resistance to Erwinia soft rot are described.

YU, M. H. Meiotic behavior of a disomic nematode-resistant sugarbeet. Crop Sci. 18:615-618. 1978.

A disomic (2n = 18) sugarbeet (Beta vulgaris L.), selection 51501, resistant to cyst nematode (Heterodera schachtii Schm.), was recovered from the progenies of resistant alien addition lines. Meiosis of this plant was not normal and

gave univalents, laggards, fragments, bridges, unequal chromosome distribution, restitution nuclei, and carry-over AI bridges. Two heterozygous paracentric inversions were evident. These aberrations were not necessarily related to the nematode resistance. Nuclear restitution occurred in either the first or second meiotic division, or both; consequently, diploid and tetraploid gametophytes were produced. More than 25% of the pollen aborted. The preliminary findings showed that nematode resistance could have been transmitted to the progenies through the pollen and ovules at an equally low rate (13%). A multiple gene hypothesis of three complementary dominant genes was proposed to interpret the phenomenon of the low frequency transmission of nematode resistance.

BOLTING AND VARIETY TRIALS, SALINAS, CALIFORNIA, 1977-78

Location: USDA Agricultural Research Station

Soil type: Sandy loam (Chualar series).

Previous crops: 1977-78 Sugarbeet test areas, Spence Field:
Block 1 - north, fallow 1975-1976; sugarbeet trials, 1974.
Block 2 - north, fallow 5 years.

Fertilizer used: Preplant: Dolomite (equivalent to 105% $CaCO_3$), as needed, was broadcast at a rate of 1100 lbs/A and disced in about 6 inches deep. All test areas had 287 lbs/A 5:20:10 applied broadcast and chiseled in before listing in October 1977. Prior to seeding, 340 lbs/A ammonium sulfate was Bye Hoe incorporated into a 9-inch band on the beds.

Supplemental nitrogen: Two applications, as sidedressed ammonium sulfate at rates ranging from 334 to 420 lbs/A.

Total fertilization (lbs/A):

N	P_2O_5	K_2O
235	57	29

Summary: 1977-78 Tests in the Salinas Valley

Test No.	Sowing Date 1977-1978	Thinning Date 1978	Test Entries No.	Reps No.	Plot Rows No.	Plot Row Lgth. Ft.	Harvest Date 1978	Test Design
178	11/17	1/11-24	176	2	1	30	- -	RCB
278-1	11/16	"	48	2	1	30	- -	RCB
278-2	"	"	32	2	1	30	- -	RCB
278-3	"	"	40	2	1	30	- -	RCB
278-4	"	"	32	2	1	30	- -	RCB
378	"	"	24	4	1	30	- -	RCB
478	"	"	20	8	1	30	9/18-19	RCB
578	11/17	"	12	8	2	30	"	RCB
678	1/31	3/8-14	12	10	2	50	9/20-25	RCB
778	"	"	16	8	2	30	9/25-26	RCB
878	"	"	22	8	2	30	9/26-28	RCB
978	2/1	"	20	8	2	30	10/2-3	RCB
1078	"	"	18	8	2	30	10/3-5	RCB
1178	"	"	24	4	1	30	- -	RCB
1278-1	"	"	10	10	1	50	10/5	Latin Sq.
1278-2	"	"	10	10	1	50	10/9	Latin Sq.
1278-3	"	"	10	10	1	50	10/9-10	Latin Sq.
1378	2/28	3/29-31	22	8	1	36	10/18-20	Split-block
1478	"	"	22	8	1	36	10/16-18	Split-block
1578	"	"	18	8	1	36	10/10-12	Split-block
1678	"	"	20	8	1	36	10/12-13	Split-plot
1778	5/4	6/1-6	144	2	1	25	- -	RCB
1878	5/2	5/29-31	2	8	2	75	10/23-24	Split-plot
1978	"	6/1-6	12	4	1	75	- -	RCB
2078	"	"	10	10	1	53	10/23	Latin Sq.

Inoculation dates (1978): Tests 1378 through 1578: May 11, with BWYV.
Test 1778: July 19 with a suspension of Erwinia bacterium.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light sprinkler irrigations were used.

Diseases and insects: Natural virus yellows infection was moderate throughout tests seeded between November 11, 1977 and February 1, 1978 (Tests 178 through 1278, Field 1). Natural infection appeared light in tests seeded between February 28 and May 4, 1978 (Field 2).

Inoculated BWYV tests 1378 through 1578 were sprayed twice with 1.7 pints/A Meta Systox R, (1) on May 12, 1978 for control of BWYV aphid vector and (2) on June 21, 1978 for control of aphid. Non-inoculated test plot areas were sprayed with 1.7 pints/A Meta Systox R for aphid control between June 5 and June 21, 1978.

A severe infestation of salt marsh caterpillar was controlled with an application of Lannate at 1 lb/A a.i. on August 19, 1978.

Powdery mildew was moderately severe in 1978 where it was not controlled and appeared first (early June) in the earliest seeded tests. Two spray applications of sulfur at rates of 15-17 lbs/A, on designated test areas, about June 15 and about July 30, 1978, provided good control of powdery mildew infection.

Downy mildew was moderately severe in 1978 and caused yield and sucrose losses in suceptible lines and their hybrids, for example in 604-13, 604-15, and their hybrids.

Natural infection of Erwinia soft rot was light and had minimum effect on yield in 1978.

Sugar analysis: Determined from two samples per plot of approximately 10 roots each or 25-40 lbs of roots at the sugar analytical laboratory, U. S. Agricultural Research Station, Salinas, California.

Remarks: The assistance of Dr. F. J. Hills and Ms. Patricia Thomas, University of California at Davis, in the analysis of test data is gratefully acknowledged.

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1977-78
(Test 178)

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 9/15 %	Downy Mildew 4/27 %	Powdery Mildew 8/3 Grade 1/
717H8	F70-546H3 x 417	3.0	0	6
717H17	5551H5 x 417	4.5	0	6
717H23	5551H21 x 417	3.0	0	6
717H24	5522-29H21 x 417	2.0	1	6
517H29	3536-97H72 x 417	0.0	4	6
517H36	3536-97H23 x 417	1.0	0	7
517TH12	546H4 x 117T	2.5	0	6
517TH17	8551H4 x 117T	0.0	0	6
517TH29	3536-97H72 x 117T	1.0	1	6
517TH36	3536-97H23 x 117T	0.0	7	6
417H21	536-97H0 x C17	0.0	1	6
417H28	536-97H3 x C17	3.0	1	6
617H11	8551H4 x 417	2.0	0	6
617H36	5536-97H22 x 417	1.0	4	7
704-13H8	F70-546H3 x 604-13	0.0	1	6
704-13H17	5551H5 x 604-13	0.0	5	6
704-13H23	5551H21 x 604-13	0.0	13	6
704-13H24	5522-29H21 x 604-13	0.0	17	6
704-15H8	F70-546H3 x 604-15	1.0	9	6
704-15H17	5551H5 x 604-15	0.0	16	5
704-15H23	5551H21 x 604-15	0.0	17	6
704-15H24	5522-29H21 x 604-15	1.0	30	5
464H2	US H6	6.5	0	5
464H8	US H7A	5.0	3	5
F71-17	Inc. F70-17	1.0	2	5
517T	Inc. 117T	1.0	0	5
504-6	Inc. 404-6 CTRS	0.0	7	6
704-6 CTRS	Inc. 504-6	0.0	16	6
704-9 CTRS	Inc. 504-9	1.5	9	6
604-13	Inc. 404-13 CTRS	1.5	17	6
704-13	Inc. 604-13	0.0	17	6
704-15	Inc. 604-15	0.0	14	5
704-15 CTRS	Inc. 504-15	1.0	34	6
704-23	Inc. 604-23	2.0	23	5
Y204	Inc. Y104A,B	9.5	14	6
Y003	Yellows resistant line	1.5	4	5
534	Inc. (aamm S. st. x 813)	5.0	7	5
464	Pollinator line	5.5	4	4
921	Composite of Type O's	16.0	7	5
F66-569H3	562H0 x 569	0.0	7	6
F70-546H3	562H0 x F63-546	2.0	1	6
4554H1	NB 1 CMS x NB 4	3.5	0	5
4554H4	3565H0 x 2554 (Iso.)	0.0	0	6
4547H1	502H0 x 547	0.0	0	6

1/ 0 = No mildew 9 = Severe mildew

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1977-78
(Test 178)

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 9/15	Downy Mildew 4/27	Powdery Mildew 8/3
		%	%	Grade
3536-97H3	562H0 x 536-97	1.5	0	7
3536-97H72	718H0 x 536-97	3.5	3	6
F75-536H1	522-29H23 x 536-97	0.0	0	7
F75-536H4	563H0 x 536-97	0.0	0	7
2522-29H23	522-25H0 x 522-29	0.0	0	7
5522-29H21	3536-97H0 x 4522-29	5.0	1	7
3522-25H85	536H61 x 522-25	0.0	4	7
6522-29H1	5522H1 x 5522-29	0.0	2	7
7522H21	4536-97H0 x 5522-29	0.0	1	7
5551H5	564H0 x 8551	2.5	0	6
5551H17	8551H4 x 8551	2.0	1	6
5551H21	3536-97H0 x 8551	2.0	0	7
6551H4	563H0 x 5551	2.0	0	7
5564H1	(502H0 x 562) x 564	0.0	3	7
6564H1	(2502H0 x 2563) x 564	0.0	0	7
Am. 7	Amalgamated variety	96.0	0	8
UI 8	Commercial hybrid	95.0	0	8
AC 5	American Crystal hybrid	82.0	2	5
AC 10	American Crystal hybrid	71.5	3	4
S72-315 (AC 7)	American Crystal hybrid	91.0	1	4
GW D2	Commercial hybrid	61.5	0	6
Yugo 89	4n line	91.5	6	3
Vytomo	Swedish variety	10.5	4	6
Bush Mono	Bush-Johnson variety	9.0	5	5
FC 3	69-9440	84.0	8	4
5941RS	Inc. Yaltushkovsk mm	90.0	6	4
6952	Inc. Uladovsk mm	87.0	6	5
6959	Inc. Ramonsk 09	92.0	5	5
5942	Inc. RW 880	54.5	11	5
Inbreds				
1502 Sp.	NB 1	8.0	8	6
7502	Inc. 3502	1.5	9	6
3592	Inc. 4592	1.5	6	6
4539	NB 7	27.5	0	7
2547	NB 5	0.0	0	4
2512	NB 6	0.0	2	5
6512	S_{16}(US 22/3 x 4200-14)	0.0	0	5
7503	Inc. 6503-1	5.5	0	5
4554	NB 4	19.5	0	5
2554 Iso.	NB 4	4.0	0	5
6554C2	Inc. 4554	17.5	0	5
6554 (S_{14})	Inc. 2554 (Iso.)	10.5	0	4
7554	Inc. 6554	7.0	2	5
F66-569	mm inbred	5.5	0	6
F70-546	Inc. F63-546	5.0	0	6

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1977-78
(Test 178)

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 9/15 %	Downy Mildew 4/27 %	Powdery Mildew 8/3 Grade
F64-550	mm inbred	2.5	3	6
5551	Inc. 551	4.5	0	5
6551	Inc. 551	3.5	0	5
6551H0	551H17 x 551	3.5	0	5
6562	S_{14}(4502 x 4570-49-12)	6.0	0	5
2562	Inc. S_{11}(4502 x 4570-49-12)	0.0	2	6
F66-562	mm inbred	4.5	0	7
F66-562H0	CMS of 562	6.5	0	7
F67-563	Inc. F63-563	1.5	0	7
F67-563H0	CMS of 563	3.0	0	7
7563	Inc. 6563(S_{14})	2.5	0	6
3565	Inc. 1565	6.5	0	6
3565H0	564H0 x 1565	7.0	0	6
5106Aa	2502aa x 4564C1	0.0	0	7
5564	Inc. 4564C1	6.5	0	6
5564H0	4564H0 x 4564C1	12.0	0	6
5564Aa	4564aa x 4564C1	6.0	0	6
4536-97	CTR inbred	7.5	0	6
4536-97H0	CMS of 536-97	4.0	0	7
5536-97R	Inc. 4536-97R	2.0	0	6
5536-97RH0	3536-97H0 x 4536-97R	1.0	2	7
F75-536	Inc. 4536-97	0.0	0	6
F75-536H0	536-97H0 x 536-97	4.0	0	6
3522-25	CTR inbred	0.0	4	7
5522-29	Inc. 4522-29	5.5	0	6
5522-29H0	4522-25H0 x 4522-29	1.0	0	7
6522-29 (Iso.)	Inc. 4522-29	3.5	0	7
6522-29	Inc. 5522-29	0.0	0	7
6522-29H0	5522-29H0 x 5522-29	2.0	0	7
C5522	Inc. 3522-25	0.0	1	7
C5522H0	3522-25H0 x 3522-25	3.0	0	7
7522	Inc. 5522-29	3.0	2	7
7522H0	5522-29H0 x 5522-29	0.0	0	7
7516C1	S_1(502aa x 5522-29) CTRS	1.5	2	7
7523C1	Inc. S_1(Type O 713A x 9522-25-5)	0.0	8	7
7524C1	Inc. S_1(Type O 704 x 9522-25-5)	9.0	1	7
7532	Inc. 502aa x 3536-97	0.0	0	6
7533	Inc. (563aa x 502Aa) x 4564C1	3.5	0	6
7534	Inc. (561aa x 536-97)aa x 4536-97	1.5	0	6
7977	Type O MM pollinator USSR	66.5	0	6
7977H0	CMS MM USSR	69.0	2	6
6507	Inc. 2563aa x 4502-1	0.0	0	6
6508	(536aa x 502Aa) x (561aa x 536)	0.0	0	6

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1977-78
(Test 178)

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 9/15	Downy Mildew 4/27	Powdery Mildew 8/3
		%	%	Grade
6510	Inc. 2502aa x 1565	0.0	0	6
5506C2	S_1(2502aa x 1565)	1.5	3	6
5505C2	S_1(2563aa x 1502 Iso.)	0.0	3	6
6505	Inc. 2563aa x 1502	0.0	0	6
7505-14	Fus. res. sel. 563aa x 502	0.0	8	6
-16		2.5	0	6
-22		1.5	2	6
-26		1.0	3	5
-30		0.0	7	6
-32		0.0	0	6
-34		3.0	3	6
-44		3.0	7	6
-52		1.5	0	6
-56		0.0	6	6
-62		4.0	0	6
-64		0.0	0	6
-66		1.0	0	6
-70		0.0	0	6
-74		1.0	0	7
-82		0.0	0	6
-98		12.5	1	6
-100		0.0	2	6
-106		0.0	1	6
-108		2.5	0	6
-114		2.5	0	6
-118		0.0	0	6
-122		0.0	1	6
-124		0.0	4	7
-126		0.0	5	6
F67-563	Inc. F63-563	0.0	0	6
1502 Sp.	NB 1	21.5	2	6
7522-6	Fusarium res. sel. 5522-29	0.0	0	6
-10		0.0	0	7
-12		2.0	0	7
-14		1.0	0	7
7522	Inc. 5522-29	1.0	0	7
6653rrC1mm	S_1[(Mac. aa x 563) x 536-97]	70.5	1	7
7536-4	Fusarium res. sel. 4536-97	0.0	1	7
4536-97	CTR inbred	0.0	0	6
7563-14	Fusarium res. sel. F67-563	5.5	0	7
-30		0.0	0	6
-40		1.0	0	6
F67-563	Inc. F63-563	1.5	0	6

TEST 278. BOLTING AND MILDEW EVALUATION TESTS, SALINAS, CALIFORNIA, 1977

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 7/11	Bolting 9/19	Downy Mildew[1]	Powdery Mildew[2] 7/17	Powdery Mildew[2] 7/28
		%	%	%	Score	Score
HYBRIDS:						
717 (C17)	Inc. 417 (Ore.)	1.0	1.0	0.0	4.5	6.0
F70-546H3	562HO x F63-546	0.0	0.0	0.0	5.5	7.0
3718H3 (Sp.)	F66-562HO x C718	1.0	4.0	1.0	6.5	7.5
US H10B	(6169) 546H3 x C17	3.0	5.0	0.0	6.5	6.5
717H8	F70-546H3 x 417 (C17)	0.0	3.0	1.0	5.5	6.5
717H4	F67-563HO x 417	0.0	1.0	0.0	5.0	6.5
717H3	F66-562HO x 417	4.5	7.5	2.0	5.0	6.5
717H33	C546H72 x 417	1.0	3.0	1.0	5.0	6.5
717HL1	C789CMS x 417	1.0	9.5	3.0	5.5	6.5
717HL2	6745HO x 417	1.0	2.0	4.0	5.0	6.5
717HL3	6755HO x 417	3.0	5.5	3.0	4.5	6.0
717HL7	6731H72 x 417	1.0	9.5	2.0	4.5	6.0
717HL8	6736H72 x 417	0.0	1.0	2.0	5.0	6.0
717HL9	6737H72 x 417	3.0	7.0	4.0	4.5	6.0
717HL10	6758-1H72 x 417	0.0	0.0	2.0	4.5	6.0
717HL11	6758-3H72 x 417	2.0	5.0	1.0	5.0	6.5
717HL12	6770H72 x 417	1.0	2.0	3.0	4.5	6.0
717HL13	C779H72 x 417	2.0	4.0	5.0	4.5	5.0
Y717H31	C718H3 x Y617 (C16)	0.0	1.0	4.0	6.0	6.5
Y717H72	C718HO x Y617	1.0	3.5	3.0	4.0	5.0
Y731H8	F70-546H3 x Y631E (C31E)	0.0	1.0	0.0	5.0	6.0
Y731H4	F67-563HO x Y631E	0.0	0.0	0.0	5.5	6.0
Y731H3	F66-562HO x Y631E	1.0	1.0	0.0	6.0	6.5
Y731HL1	C789CMS x Y631E	2.0	8.5	0.0	6.0	6.5
Y731HL2	6745HO x Y631E	0.0	2.0	6.0	6.0	6.0
Y731HL3	6755HO x Y631E	0.0	1.0	3.0	5.5	5.0
Y731HL4	6796-1HO x Y631E	0.0	3.0	2.0	5.5	5.5
Y731HL5	6796-2HO x Y631E	4.0	4.0	1.0	6.0	5.5
Y731HL6	6730H72 x Y631E	1.0	4.0	1.0	4.5	6.5
Y631HL7	6731H72 x Y631E	1.0	4.5	2.0	5.5	6.5
Y731HL8	6736H72 x Y631E	0.0	1.0	0.0	6.0	6.5
Y731HL9	6737H72 x Y631E	0.0	4.0	6.0	4.0	5.5
Y731HL10	6758-1H72 x Y631E	0.0	4.0	0.0	5.0	6.0
Y731HL11	6758-3H72 x Y631E	1.0	5.0	4.0	5.0	5.0
Y731HL12	6770H72 x Y631E	0.0	1.0	6.5	5.0	5.0
Y731HL13	C779H72 x Y631E	1.0	6.5	4.0	3.5	4.5
Y740H29	C536H72 x Y640	2.5	5.5	1.0	6.0	6.5
Y741H29	C536H72 x Y641	5.0	7.5	0.0	5.5	6.5
Y741HL4	6796-1HO x Y641	15.0	18.0	3.0	4.5	6.0
Y741HL5	6796-2HO x Y641	3.5	12.5	0.0	4.0	5.0

1/ Downy mildew rated as % of plants on 4/26/78 that showed downy mildew infection.
2/ Powdery mildew scored from 0 to 9 (0 = no mildew, 9 = severe mildew).

TEST 278. BOLTING AND MILDEW EVALUATION TESTS, SALINAS, CALIFORNIA, 1977 cont.

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 7/11	Bolting 9/19	Downy Mildew	Powdery Mildew 7/17	Powdery Mildew 7/28
		%	%	%	Score	Score
Y746H29	C536H72 x Y646	2.0	3.0	2.0	5.0	4.5
E702H31	C718H3 x E602 (C02)	2.5	9.5	1.5	7.5	7.0
E706H31	C718H3 x E606	4.5	8.5	5.0	6.5	6.5
E736H29	C536 x E536 (C36)	0.0	2.0	3.5	7.0	7.0
E736H31	C718H3 x E536	2.0	3.5	3.0	6.5	6.0
E702H8	F70-546H3 x E602	0.0	1.5	3.5	6.0	7.5
E706H8	F70-546H3 x E606	1.0	4.0	1.0	5.5	6.5
E736H8	F70-546H3 x E536 (C36)	3.0	4.5	1.0	6.5	6.5
OPEN-POLLINATED:						
Y740	Inc. Y640	5.0	8.0	3.0	3.5	5.0
Y741	Inc. Y641	13.0	20.5	3.0	4.0	4.0
Y731 (C31E)	Inc. Y631E	1.0	4.5	11.0	4.0	4.0
Y631 (C31)	Inc. Y331	1.0	3.5	11.0	3.0	5.0
Y601 (C01)	Inc. Y401A	5.5	22.0	4.5	4.0	4.5
Y744A (C32)	ERS 4247	25.0	25.0	2.0	4.0	4.0
Y744B (C32)	ERS 3209	31.5	52.5	4.5	4.5	4.5
Y723	YRS Y523	15.0	44.5	5.5	4.5	4.5
Y726	YRS Y526	31.5	46.5	0.0	6.0	6.5
Y730	YRS Y430	10.0	15.0	0.0	8.0	8.5
Y743 (C43)	ERS 5202	12.5	14.0	2.5	5.0	6.0
Y717 (C16)	Inc. Y617 (Iso.)	0.0	0.0	0.0	4.5	5.0
Y717H0 (C16CMS)	Y617H0 x Y617	1.5	3.5	2.0	4.0	5.0
717 (C17)	Inc. 417 (Ore.)	1.0	3.0	2.0	5.0	5.5
417 (Ore.)(C17)	Inc. 813A	1.0	3.5	3.5	5.0	6.0
E737	ERS E537	0.0	1.0	1.0	5.5	6.0
Y746	Inc. Y646	0.0	2.0	2.0	4.5	5.0
F77-23	Inc. C23 (stripped seed)	4.0	5.5	3.5	6.0	7.0
F70-13	Inc. F66-13	5.5	10.0	5.0	6.5	6.5
F77-02	Inc. C02 (stripped seed)	4.5	6.0	11.5	6.5	6.5
E702 (Iso.)	ERS E402	0.0	3.0	9.5	6.0	6.5
E702 (C02)	Inc. E602	0.0	2.5	10.5	5.0	5.5
E702 (MS)	MS x E602	8.0	9.5	7.0	5.0	5.5
E536 (Sp.)	Inc. E-#'s	3.5	3.5	21.0	5.0	5.5
E736 (C36)	Inc. E536 (Iso.)	6.0	7.5	4.0	4.5	4.5
E736 (MS)	MS x E536 (Iso.)	0.0	2.0	2.0	4.5	5.5
F77-36	Inc. C36 (stripped seed)	7.0	8.5	2.0	4.5	5.5
E736 (Iso.)	ERS E536 (Iso.)	2.0	3.0	2.0	5.0	5.0
E506 (Sp.)	Inc. E506-#'s	4.0	7.0	0.0	5.0	5.5
E706	Inc. E606	5.0	12.0	10.0	4.0	5.0
E706 (MS)	MS x E606	2.5	8.0	3.5	4.0	5.0
E738	ERS E538	0.0	2.0	4.0	4.5	6.5

TEST 278. BOLTING AND MILDEW EVALUATION TESTS, SALINAS, CALIFORNIA, 1977 cont.

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 7/11	Bolting 9/19	Downy Mildew	Powdery Mildew 7/17	Powdery Mildew 7/28
		%	%	%	Score	Score
SELF-FERTILE, RANDOM MATING:						
7740B	YRS 5740 (A,aa)	8.0	8.0	2.0	5.0	6.0
7740	6740aa x A	5.5	6.5	1.0	5.5	6.0
7740HO	5740HO x 6740	5.0	12.0	0.0	5.5	7.0
7741B	YRS 5741 (A,aa)	1.0	4.0	2.0	5.5	6.5
7741	6741aa x A	4.0	9.5	2.0	5.0	6.0
7741HO	5741HO x 6741	2.0	3.5	4.0	5.5	7.0
7742	YRS 5742 (A,aa)	11.5	14.5	1.0	5.0	6.0
7744	YRS C789 (A,aa)	1.0	4.5	1.0	5.0	6.5
7745	YRS 5745 (A,aa)	1.0	3.0	0.0	4.5	6.0
7755B	YRS 5755 (A,aa)	9.0	15.0	0.0	4.5	4.0
7755	6755aa x A	5.0	12.0	3.0	4.5	4.5
7755HO	6755HO x 6755	4.5	11.5	1.0	4.0	4.5
7789	6789aa x A	11.5	11.5	0.0	5.0	5.5
7789HO	6744HO x 6789	5.0	9.0	0.0	5.0	6.0
7790	6790aa x A	1.0	3.0	0.0	4.5	5.5
7790HO	6745HO x 6790	4.0	7.0	1.0	5.5	6.0
7796-1	6796-1aa x A	4.5	5.5	1.5	5.0	5.5
7796-1HO	6796-1HO x 6796-1	0.0	2.5	1.5	5.5	6.0
7796-2	6796-2aa x A	2.5	8.0	0.0	6.0	7.0
7796-2HO	6796-2HO x 6796-2	2.5	11.0	2.5	6.0	7.0
7747-1	6219aa x E-comp.	4.5	7.0	2.5	5.0	5.5
7747-2	6220aa x E-comp.	0.0	5.5	0.0	5.5	5.0
7747-3	6221aa x E-comp.	0.0	0.0	1.0	6.5	6.0
7748-1	6796-1aa x E-comp.	4.5	8.0	7.0	5.5	6.0
7748-2	6796-2aa x E-comp.	4.0	9.0	1.0	5.5	5.5
6791	4791, D aa x A	6.0	10.5	2.5	5.5	6.0
7790C	5790-CO(S_1)aa x A	1.0	2.5	3.5	5.5	5.5
7790D	5790-SY(S_1)aa x A	1.0	3.0	2.0	5.5	6.0
7790E	5790-SY(TX)aa x A	2.5	3.5	0.0	5.5	6.5
7790F	5790-SY(S_1-TX)aa x A	0.0	2.0	0.0	5.0	7.0
7790G	5790-%S(S_1)aa x A	3.5	4.5	1.0	5.0	6.5
7790H	5790-LSY(S_1)aa x A	0.0	1.0	1.0	4.5	6.0
7790I	5790-LSY(TX)aa x A	0.0	2.5	4.0	5.0	6.0
7790J	5790-L%S(S_1)aa x A	1.5	6.5	1.5	5.0	6.0
6746	5791B,G,H,...⊗	11.0	13.0	1.0	5.5	6.5
Y645	Inc. 3204 (Acc. 125)	65.0	81.0	8.5	2.5	3.5
6226	F_1B_3(C17 x FC 702/2)Cb-	4.0	12.0	0.0	4.5	5.0
6231	S_1B_1(C563 x FC 702/2)Cb-	0.0	2.0	1.0	5.5	5.5
7758-1H37	C16CMS x 6758-1	1.0	1.0	0.0	5.0	5.5
7758-3H37	C16CMS x 6758-3	1.0	1.0	2.0	4.5	5.5

TEST 278. BOLTING AND MILDEW EVALUATION TESTS, SALINAS, CALIFORNIA, 1977 cont.

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 7/11 %	Bolting 9/19 %	Downy Mildew %	Powdery Mildew 7/17 Score	Powdery Mildew 7/28 Score
SELF-FERTILE:						
F71-705	Inc. C0705	7.0	8.5	1.0	5.0	5.5
F71-705H0	C0705H0 x C0705	11.0	13.0	4.5	4.0	5.0
7705	ERS C706	0.0	0.0	0.0	5.0	4.5
7705H0	ERS C706H0 x ERS C706	1.0	5.5	0.0	5.5	5.5
F74-718	Inc. C718	2.5	7.0	2.0	4.5	5.0
F74-718H0	C718H0 x C718	4.0	15.0	2.5	5.5	7.5
3718 (Sp.)	Inc. C718	0.0	1.0	8.5	5.0	5.5
3718H0(A) Sp.	C718H0 x C718	1.5	1.5	6.5	5.0	6.5
7730	Inc. 6730	3.0	10.5	9.5	5.0	6.5
7730H2	6730H72 x 6730	4.5	13.0	2.0	5.5	6.5
7730H3	F66-562H0 x 6730	0.0	6.0	6.0	5.5	7.0
7730H72	C718H0 x 6730	5.5	9.0	5.0	4.5	5.5
7731	Inc. 6731	1.0	1.0	5.0	6.5	7.0
7758-1	Inc. 6758-1	0.0	0.0	0.0	4.5	5.0
7758-1H2	6758-1H72 x 6758-1	0.0	1.0	0.0	4.5	6.0
7758-1H3	F66-562H0 x 6758-1	0.0	0.0	1.0	5.0	5.5
7758-1H72	C718H0 x 6758-1	0.0	1.0	1.0	5.0	6.0
7758-3	Inc. 6758-3	1.0	1.0	3.0	4.0	4.0
7758-3H0	3536-97H54 x 6758-3	1.5	1.5	0.0	5.0	6.0
7758-3H2	6758-3H72 x 6758-3	0.0	0.0	3.5	5.0	5.5
7758-3H3	F66-562H0 x 6758-3	0.0	1.0	1.0	5.5	6.5
7758-3H72	C718H0 x 6758-3	0.0	0.0	5.5	5.5	6.5
7778	Inc. 5778	0.0	0.0	13.0	3.5	4.0
7779 (C779)	Inc. 5779	0.0	4.0	19.5	2.0	2.5
7717	BRS 4232	0.0	0.0	1.5	4.0	4.0
6719	ERS 4717	0.0	2.5	4.0	3.0	5.0
2512	NB 6	0.0	0.0	4.0	4.5	5.0
F66-562H0	562H0 x 562	1.5	13.5	0.0	6.5	7.0
F67-563H0	563H0 x 563	0.0	0.0	0.0	6.5	7.0
F70-546	Inc. 546	3.0	3.0	1.5	5.0	5.5
3546	Inc. F70-546	4.5	5.5	1.0	5.5	6.0
7546E	ERS F70-546	2.0	3.5	1.0	5.0	6.5
7562E	ERS F66-562	3.0	3.0	0.0	6.0	5.0
7562EH0	ERS 562H0 x ERS 562	0.0	0.0	0.0	6.0	6.0
7563E	ERS F67-563	2.0	5.0	0.0	7.0	7.0
7563EH0	ERS 563H0 x ERS 563	0.0	0.0	0.0	5.0	6.0
6799	Inc. 4799(A,aa)	3.0	18.0	0.0	5.0	6.0
3600	Inc. 6600	100.0	100.0	0.0	--	--
5204	4212 CMS x 8500	79.0	79.0	11.0	--	--
8500H0	1460H0 x 1460	100.0	100.0	--	--	--

TEST 278. BOLTING AND MILDEW EVALUATION TESTS, SALINAS, CALIFORNIA, 1977 cont.

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1977

Variety	Description	Bolting 7/11 %	Bolting 9/19 %	Downy Mildew %	Powdery Mildew 7/17 Score	Powdery Mildew 7/28 Score
7201	6209 bmbm⊗	0.0	0.0	9.0	6.0	6.0
7202	6209 Bmbm⊗	4.0	7.0	7.0	6.0	5.0
7203	6217 bmbm⊗	0.0	2.0	5.0	6.0	6.0
7204	6217 BmBm⊗	2.0	2.0	7.0	7.0	6.0
7205	6211 bmbm⊗	0.0	0.0	8.0	5.0	5.0
7206	6211 Bmbm⊗	0.0	0.0	2.0	5.0	5.0
7207	6212 bmbm⊗	4.0	7.0	4.0	6.0	5.0
7208	6212 BmBm⊗	0.0	0.0	2.0	5.0	5.0
Y723	YRS Y523	14.9	24.2	6.8	--	--
Y726	YRS Y526	37.8	46.2	0.6	--	--
E506 (Iso.)	Inc. E406, E4	2.5	4.7	1.0	--	--
E736 (Iso.)	ERS E536 (Iso.)	1.3	4.2	0.5	--	--
7744	YRS 5744 (A,aa)	2.8	5.2	8.4	--	--
7745	YRS 5745 (A,aa)	0.3	2.7	9.1	--	--
7755B	YRS 5755B (A,aa)	9.9	16.7	0.5	--	--
6719	ERS 4717	0.8	1.7	6.0	--	--

TEST 578. BOLTING AND YIELD EVALUATION OF HYBRIDS, SALINAS, CALIFORNIA, 1977-78

12 var., 8 reps., RCB
2-row plots, 30 ft. long

Planted: November 17, 1977
Harvested: September 18-20, 1978

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot[1]/ Percent	Downy Mildew[2]/ Percent	Bolting 7/11 Percent	Bolting 9/15 Percent	Powdery Mildew 7/17 Rating	Powdery Mildew 7/29 Rating
Y731H8	F70-546H3 x C31E1	10,871	34.85	15.66	167	0.5	0.5	0.4	0.7	4.8	6.5
Y601H8	F70-546H3 x C01	10,864	34.78	15.67	166	0.1	1.1	0.8	3.0	4.8	6.4
Y741H8	F70-546H3 x Y641	10,801	35.88	15.14	161	0.1	1.4	1.8	4.3	4.5	6.0
Y740H8	F70-546H3 x Y640	10,606	36.81	14.46	172	0.0	0.7	1.5	3.7	5.0	6.6
464H8	F70-546H3 x F66-64	10,564	35.39	14.99	167	0.0	0.7	0.7	2.2	4.8	6.6
E736H8	F70-546H3 x C36	10,489	35.90	14.63	160	0.1	0.4	0.9	2.0	5.6	7.4
Y746H8	F70-546H3 x Y646	10,461	34.88	15.09	160	0.0	0.7	0.5	1.4	4.6	6.6
717H8	F70-546H3 x C17	10,458	35.53	14.76	172	0.1	0.4	0.3	1.2	5.5	6.6
E706H8	F70-546H3 x E606	10,083	34.72	14.54	170	0.0	0.8	1.5	3.4	5.5	7.1
E702H8	F70-546H3 x C02	9,870	35.09	14.07	161	0.0	0.3	0.5	1.6	5.9	7.3
704-15H8	F70-546H3 x 604-15	9,101	31.09	14.69	164	1.3	1.3	0.2	0.8	5.5	7.5
704-13H8	F70-546H3 x 604-13	8,875	30.50	14.63	166	0.8	0.5	0.0	0.3	6.0	7.6
Mean		10,254	34.62	14.86	165	0.3	0.7	0.8	2.1	5.2	6.9
LSD (.05)		790	2.97	0.58	NS	0.7	NS	0.8	1.3	0.6	0.6
Coefficient of Variation(%)		7.7	8.6	3.9	5.6	282.7	135.9	113.9	61.8	11.3	9.5
F value		5.6**	3.2**	5.3**	1.8	2.5*	1.1	3.7**	8.3**	6.4**	4.8**

1/ % roots with Erwinia soft rot detected at harvest.
2/ Plants with downy mildew infection on 4/26/78. Incidence increased as season progressed.

TEST 678. CURLY TOP RESISTANT HYBRID EVALUATION, SALINAS, CALIFORNIA, 1978

12 var. with 10 replications
2-row plots, 50 ft. long

Planted: January 31, 1978
Harvested: September 20 & 25, 1978

Variety	Description	Acre Yield		Sucrose	Downy Mildew	Root Rot	Beets/ 100'
		Sugar	Beets				
		Pounds	Tons	Percent	Percent	Percent	Number
717H17	5551H5 x 417	11,617	35.59	16.32	6.2	0.2	136
717H8	F70-546H3 x 417	11,310	34.38	16.45	8.8	0.2	142
717H24	5522-29H21 x 417	11,222	34.10	16.45	9.4	0.1	145
717H23	5551H21 x 417	11,122	34.39	16.17	6.5	0.3	133
704-13H8	F70-546H3 x 604-13	10,022	30.48	16.44	5.1	0.0	143
704-15H17	5551H5 x 604-15	9,829	29.82	16.48	4.3	0.1	134
704-15H8	F70-546H3 x 604-15	9,576	29.23	16.38	7.6	0.1	141
704-15H23	5551H21 x 604-15	9,570	29.23	16.37	5.5	0.1	137
704-13H17	5551H5 x 604-13	9,528	30.44	15.65	3.7	0.1	132
704-13H23	5551H21 x 604-13	8,732	27.39	15.94	5.4	0.1	135
704-15H24	5522-29H21 x 604-15	8,659	27.06	16.00	8.6	0.2	141
704-13H24	5522-29H21 x 604-13	8,177	25.91	15.78	10.2	0.1	140
Mean		9,920	30.67	16.20	6.8	0.12	138
LSD (.05)		840	2.37	.42	3.51	NS	6.0
C. V. (%)		9.5	8.7	2.9	58.3	255.8	4.8
F value		14.37**	14.65**	3.81**	2.83**	.64	4.08**

*Exceeds the 5% level of significance (F = 1.88).
**Exceeds the 1% level of significance (F = 2.43).

TEST 778. HYBRID TEST, SALINAS, CALIFORNIA, 1978

16 varieties, 8 reps., RCB
2-row plots, 30 ft. long

Planted: January 31, 1978
Harvested: September 25-26, 1978

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot[1] Percent	Downy Mildew[2] Percent	Bolting Percent
E706H8	F70-546H3 x E606	12,703	37.11	17.19	134	0.2	2.2	0.3
Y740H8	F70-546H3 x Y640	12,548	36.15	17.43	148	0.0	0.7	0.3
Y601H8	F70-546H3 x C01	12,533	35.56	17.71	134	0.2	1.0	0.0
Y731H8	F70-546H3 x C31E1	12,482	36.03	17.43	139	0.2	0.5	0.0
US H10B	546H3 x C17 (6169)	12,391	36.84	16.89	148	0.2	2.6	0.0
E536H8	F70-546H3 x C36	12,336	36.61	16.93	129	0.0	2.5	0.3
Y746H8	F70-546H3 x Y646	12,327	36.23	17.06	139	0.2	1.4	0.2
Y526H8	F70-546H3 x Y426	12,300	35.15	17.57	137	0.0	0.6	0.8
Y523H8	F70-546H3 x Y423	12,284	35.93	17.22	135	0.2	0.5	0.3
717H8	F70-546H3 x C17	12,282	36.25	17.05	140	0.2	1.7	0.0
Y741H8	F70-546H3 x Y641	12,241	34.67	17.68	139	0.2	0.8	0.1
E702H8	F70-546H3 x C02	12,127	36.17	16.82	140	0.0	1.2	0.2
E736H8	F70-546H3 x C36	11,899	35.41	16.89	141	0.0	1.6	0.0
464H8	F70-546H3 x F66-64	11,881	33.99	17.53	134	0.3	0.8	0.2
704-13H8	F70-546H3 x 604-13	11,647	34.48	16.93	146	0.2	0.6	0.0
704-15H8	F70-546H3 x 604-15	11,341	32.83	17.32	152	0.0	1.6	0.7
Mean		12,208	35.59	17.23	140	0.1	1.3	0.2
LSD (.05)		594	1.61	0.62	10.8	NS	NS	0.4
Coefficient of Variation (%)		4.9	4.6	3.6	7.8	371.0	143.0	213.0
F value		2.8**	3.9**	1.9*	2.6**	0.5	1.3	2.4**

1/ % roots with Erwinia soft rot detected at harvest.
2/ Plants with downy mildew infection on 4/26/78. Incidence increased as season progressed.

TEST 1078. HYBRID TEST: EVALUATION OF RANDOM-MATING POPULATIONS, SALINAS, CALIFORNIA, 1978

18 varieties, 8 reps., RCB
2-row plots, 30 ft. long

Planted: February 1, 1978
Harvested: October 3-5, 1978

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Downy Mildew
		Sugar	Beets				
		Pounds	Tons	Percent	Number	Percent	Percent
717HL3	6755HO(B) x C17	13,910	43.57	16.02	136	0.5	1.5
Y731H8	F70-546H3 x C31E1	13,851	42.04	16.53	138	0.0	0.1
Y731HL3	6755HO(B) x C31E1	13,753	42.71	16.14	139	0.0	0.7
Y741HL4	6796-1HO x Y641	13,141	40.86	16.12	118	0.0	0.9
Y731HL1	C789HO x C31E1	13,112	40.55	16.19	135	0.2	0.3
Y731HL5	6796-2HO x C31E1	12,986	40.69	15.98	124	0.0	1.0
Y731HL4	6796-1HO x C31E1	12,964	40.67	15.99	140	0.0	0.6
Y741HL5	6796-2HO x Y641	12,911	40.74	15.88	125	0.2	0.5
US H10B	546H3 x C17(6169)	12,686	40.80	15.56	137	0.1	0.9
7789H37	C16HO x 6789	12,631	40.24	15.72	118	0.3	2.0
717HL1	C789HO x C17	12,484	40.42	15.50	140	0.2	1.7
7755H37	C16HO x 6755	12,434	41.61	14.95	117	0.4	0.8
Y731HL2	6745HO x C31E1	12,431	39.03	15.94	129	0.2	0.2
7790DH37	C16HO x 5790-SY(S_1)	12,392	40.31	15.41	117	0.0	0.9
717HL2	6745HO x C17	12,136	39.19	15.55	126	0.0	1.3
7741H37	C16HO x T-O-Sel. 6741	12,068	39.26	15.43	109	0.0	2.0
7790H37	C16HO x 6790	11,983	39.40	15.24	115	0.7	1.9
7740H37	C16HO x T-O-Sel. 6740	11,575	37.36	15.49	119	0.6	2.1
Mean		12,747	40.52	15.76	127	0.2	1.1
LSD (.05)		811	2.27	0.51	9.5	NS	NS
Coefficient of Variation (%)		6.4	5.7	3.3	7.6	272.0	167.0
F value		5.1**	3.1**	4.8**	9.0**	1.7	1.1

TEST 1378: (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MALES, FEMALES, AND HYBRIDS
SALINAS, CALIFORNIA, 1978

Split-block with 8 replications
22 varieties and 2 virus treatments
1-row plots, 36 ft. long

Planted: February 28, 1978
Noninoculated
Harvested: October 18-20, 1978

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Bolting	Beets/ 100'
Males		Pounds	Tons	Percent	Percent	Percent	Number
417	Inc. C17	14,354	44.45	16.18	2.5	0.0	141
Y731	Inc. C31E1	14,668	42.51	17.29	0.2	0.0	139
364	Inc. F66-64	13,826	43.46	15.94	0.5	0.0	142
Females							
F70-546H3	C562HO x C546	12,604	37.96	16.66	0.0	0.0	145
3718H54	C706HO x C718	13,848	42.19	16.44	0.2	0.0	149
Hybrids							
717H8	F70-546H3 x C17	15,715	47.52	16.57	0.7	0.0	148
Y731H8	" x C31E1	15,832	45.91	17.28	0.2	0.0	143
464H8	" x F66-64	15,124	45.83	16.56	0.3	0.0	151
717H82	3718H54 x C17	15,514	48.60	16.03	2.8	0.0	143
Y731H82	" x C31E1	14,994	45.91	16.38	0.3	0.0	141
364H82	" x F66-64	15,191	46.85	16.24	0.5	0.0	146
Other Hybrids							
717H24	(C536HO x C522) x C17	15,780	49.65	15.93	1.5	0.0	145
704-13H24	(" x ") x 604-13	11,809	40.60	14.59	0.3	0.0	147
704-15H24	(" x ") x 604-15	12,524	40.90	15.36	0.0	0.4	154
E736H8	F70-546H3 x C36	15,401	47.87	16.13	0.0	0.0	144
Y731HL13	(C718HO x C779) x C31E1	15,592	48.28	16.21	1.0	0.0	146
Y731HL1	C789HO x C31E1	15,801	46.69	16.96	0.5	0.0	145
Y731HL2	6745HO x C31E1	15,291	45.80	16.74	0.5	0.0	149
Y731HL4	6796-1HO x C31E1	15,317	45.93	16.71	0.3	0.0	142
Y731HL5	6796-2HO x C31E1	14,808	44.78	16.57	0.3	0.0	144
US H20	Lot 8231	14,550	43.78	16.65	0.0	4.3	148
Hh 2X Mono 81	Hilleshög	13,949	40.28	17.35	1.1	0.0	151
Mean1/		14,659	44.81	16.40	0.6	0.2	146
LSD (.05)		695	2.0	0.41	1.1	0.6	7.6
Coefficient of Variation (%)		4.8	4.6	2.5	177.9	304.0	5.3
F value		21.2**	17.4**	18.3**	3.8**	15.8**	2.0**

1/Virus treatment means and variety x virus treatment interactions were significantly different at the 1% level for sugar yield, beet yield, and % sucrose.

TEST 1378: (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MALES, FEMALES, AND HYBRIDS
SALINAS, CALIFORNIA, 1978

Split-block with 8 replications
22 varieties and 2 virus treatments
1-row plots, 36 ft. long

Planted: February 28, 1978
Inoculated: May 11, 1978
Harvested: October 18-20, 1978

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Yellow Scores[3]		Root	Beets/
		Inoc.	Loss[2]	Inoc.	Loss	Inoc.	Loss	6/29	7/12	Rot	100'
Males		Lbs/A	%	T/A	%	%	%			%	Number
417	Inc. C17	12,835	10.6	42.06	5.4	15.31	5.5	2.5	2.8	6.7	145
Y731	Inc. C31E1	12,337	15.9	37.99	10.7	16.31	5.8	4.0	5.0	0.0	138
364	Inc. F66-64	10,475	23.9	35.27	18.7	14.88	6.6	6.4	7.0	0.3	141
Females											
F70-546H3	C562HO x C546	10,458	16.9	34.06	10.2	15.40	7.5	6.3	7.0	0.0	145
3718H54	C706HO x C718	11,943	13.6	39.01	7.2	15.32	6.9	4.6	4.6	0.0	150
Hybrids											
717H8	F70-546H3 x C17	13,533	13.8	43.35	8.9	15.69	5.4	3.9	4.1	0.5	146
Y731H8	" x C31E1	13,450	14.9	41.73	8.8	16.13	6.6	4.6	5.3	0.0	145
464H8	" x F66-64	11,775	22.1	37.94	17.1	15.55	6.1	5.9	6.4	0.3	145
717H82	3718H54 x C17	13,548	12.5	44.37	8.3	15.29	4.5	3.6	3.9	1.9	141
Y731H82	" x C31E1	13,492	9.8	42.35	7.8	15.96	2.3	4.3	4.6	0.7	145
364H82	" x C31E1	12,001	21.0	39.96	14.8	15.10	7.1	5.1	5.6	0.3	144
Other Hybrids											
717H24	(C536HO x C522) x C17	13,541	13.9	45.21	8.6	15.00	5.8	3.5	3.9	2.6	140
704-13 H24	(" x ") x 604-13	9,906	16.3	35.78	12.0	13.91	4.7	5.3	5.4	0.6	139
704-15 H24	(" x ") x 604-15	10,026	19.8	35.78	12.7	14.09	8.2	6.0	6.6	0.0	150
E736H8	F70-546H3 x C36	13,215	14.2	43.00	10.1	15.40	4.5	4.0	4.9	0.0	141
Y731HL13	(C718HO x C779) x C31E1	13,361	14.1	43.00	10.5	15.56	4.0	4.1	4.4	1.1	139
Y731HL1	C789HO x C31E1	13,520	14.2	41.46	11.1	16.33	3.6	4.5	4.6	0.0	140
Y731HL2	6745HO x C31E1	12,944	15.2	40.12	12.3	16.17	3.4	4.8	5.0	0.0	140
Y731HL4	6796-1HO x C31E1	13,419	12.3	42.60	7.1	15.78	5.5	4.3	5.0	0.0	140
Y731HL5	6796-2HO x C31E1	12,853	13.2	40.33	9.9	15.96	3.6	4.5	4.9	0.2	138
US H20	Lot 8231	10,244	29.5	33.76	22.9	15.21	8.6	7.3	7.5	0.0	142
Hh 2X Mono 81	Hilleshög	10,619	23.8	32.50	19.3	16.38	5.6	7.0	7.9	1.3	140
Mean[1]		12,250	16.4	39.62	11.6	15.49	5.5	4.8	5.3	.7	142
LSD (.05)		686	5.2	2.0	4.3	0.43	3.3	0.6	0.6	1.5	7.0
Coefficient of Variation (%)		5.7	31.9	5.2	37.8	2.8	60.4	12.5	11.5	211.0	5.0
F value		30.2**	7.1**	26.5**	8.3**	18.0**	1.9**	31.4**	36.3**	7.3**	2.0**

2/LSD (.05) for differences within varieties for different virus treatments were 587 lbs/A, 1.52 tons/A, and 0.38% sucrose. These differences represent approximately 4.1, 3.4, and 2.3% losses, respectively.

3/Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms. A correlation of r = 0.86 occurred between yellows scores and sugar yield % loss.

TEST 1478: (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MULTIGERM BREEDING LINES
SALINAS, CALIFORNIA, 1978

Split-block with 8 replications
2 virus treatments
1-row plots, 36 ft. long

Planted: February 28, 1978
Noninoculated check
Harvested: October 16-18, 1978

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
Y601	Inc. Y401A(C01)	14,809	43.91	16.88	124	1.2
Y741	Inc. Y641	14,348	42.49	16.94	132	0.0
Y730	YRS Y430	14,303	43.89	16.29	142	0.5
Y731	Inc. Y631E(C31E1)	14,112	41.38	17.07	129	0.0
Y746	Inc. Y646	13,843	42.49	16.32	133	0.0
Y003	Inc. Y803	13,792	41.41	16.71	121	0.3
Y740	Inc. Y640	13,669	43.27	15.81	143	0.4
417	Inc. 713A(C17)	13,479	41.92	16.13	135	1.5
Y723	YRS Y523	13,401	40.50	16.59	137	0.3
464	Inc. F66-64	13,383	41.30	16.23	130	0.0
E737	ERS E537	13,342	40.95	16.32	147	0.0
Y726	YRS Y526	13,192	39.04	16.93	131	0.0
E706	Inc. E606	12,601	40.79	15.46	134	0.0
F77-36	Inc. C36(7322)	12,600	41.41	15.23	140	0.5
E736	Inc. E536(C36)	12,573	41.63	15.14	129	0.5
E702	Inc. E602(C02)	12,529	40.28	15.57	133	0.0
E736	ERS C36	12,384	40.36	15.38	133	0.3
468	Inc. 868(US 75)	12,293	38.93	15.82	125	0.7
SP6822-0	Lot 0147	12,243	37.61	16.31	143	0.2
Y645	Inc. 3204	12,194	37.72	16.19	128	0.0
704-13	Inc. 604-13	9,135	33.68	13.54	140	0.7
704-15	Inc. 604-15	7,971	30.37	13.13	128	2.2
Mean[1/]		12,827	40.24	15.91	134	0.4
LSD (.05)		1,103	3.09	0.55	12.4	0.9
Coefficient of Variation (%)		8.7	7.8	3.5	9.4	210.8
F value		16.2**	8.3**	26.4**	2.4**	3.3**

1/Virus treatment means and variety x virus treatment interactions were significantly different at least at the 5% level for sugar yield, beet yield, and % sucrose.

TEST 1478: (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MULTIGERM BREEDING LINES
SALINAS, CALIFORNIA, 1978

Split-block with 8 replications
22 varieties x 2 virus treatments
1-row plots, 36 ft. long

Planted: February 28, 1978
BWYV Inoculated: May 11, 1978
Harvested: October 16-18, 1978

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss[2]	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Yellows Score[3] 6/29	Yellows Score[3] 7/12	Root Rot	Beets/ 100'
		Lbs/A	%	T/A	%	%	%			%	Number
Y601	Inc. Y401A(C01)	13,685	6.9	42.03	3.7	16.32	3.2	4.1	4.4	0.8	127
Y741	Inc. Y641	12,099	15.0	38.72	8.5	15.73	7.2	5.0	5.3	0.0	132
Y730	YRS Y430	12,544	12.2	40.04	8.7	15.66	3.8	5.4	5.1	0.3	147
Y731	Inc. Y631E(C31E1)	12,403	11.8	38.53	6.7	16.16	5.4	4.3	4.4	0.0	130
Y746	Inc. Y646	11,936	13.7	39.04	8.3	15.36	5.9	4.1	4.0	0.5	133
Y003	Inc. Y803	12,081	12.4	37.72	9.1	16.13	3.4	3.5	4.3	0.3	116
Y740	Inc. Y640	11,587	15.3	38.40	11.2	15.12	4.4	4.6	4.8	0.0	134
417	Inc. 713A(C17)	12,775	4.9	41.65	0.3	15.41	4.4	2.4	3.0	3.8	144
Y723	YRS Y523	9,962	25.5	32.58	19.4	15.32	7.6	5.8	6.9	0.0	136
464	Inc. F66-64	10,438	21.9	34.38	16.6	15.19	6.4	6.1	6.5	0.0	136
E737	ERS E537	12,520	6.2	39.71	3.2	15.80	3.1	2.8	3.0	0.0	146
Y726	YRS Y526	11,727	10.9	36.75	5.8	16.01	5.5	6.0	6.3	0.2	139
E706	Inc. E606	11,647	6.8	39.01	3.9	14.99	2.9	2.6	3.3	0.0	137
F77-36	Inc. C36(7322)	10,866	13.3	38.21	7.7	14.28	6.1	3.9	4.0	0.0	142
E736	Inc. E536(C36)	11,583	7.4	39.23	5.5	14.76	2.2	3.3	3.8	0.0	145
E702	Inc. E602(C02)	10,919	12.3	38.15	5.1	14.36	7.8	3.8	4.0	0.2	136
E736	ERS C36	11,579	6.1	38.64	4.0	15.07	1.8	3.8	3.9	0.2	140
468	Inc. 868(US 75)	9,453	23.0	31.50	18.9	15.01	5.0	6.9	7.0	0.5	136
SP6822-0	Lot 0147	7,710	37.1	26.47	29.8	14.59	10.5	7.9	8.3	0.2	147
Y645	Inc. 3204	11,067	9.1	35.14	6.8	15.76	2.3	4.8	5.6	0.3	131
704-13	Inc. 604-13	7,767	14.2	31.13	7.4	12.54	7.2	4.4	4.3	0.5	136
704-15	Inc. 604-15	6,794	14.0	27.19	10.3	12.54	4.2	6.5	7.0	2.8	138
Mean[1]		11,052	13.6	36.56	9.1	15.10	5.0	4.6	4.9	0.5	137
LSD (.05)		927	8.1	3.16	7.0	0.57	NS	0.7	0.6	1.0	10.9
Coefficient of Variation (%)		8.5	59.9	8.7	77.5	3.8	99.0	14.4	12.0	214.5	8.1
F value		28.1**	6.9**	14.4**	7.2**	24.4**	1.5	37.7**	49.1**	6.6**	3.4**

2/LSD (.05) for differences within varieties for different virus treatments were 800 lbs sugar/A, 2.2 tons/A, and 0.54% sucrose. These differences represent approximately 6.2, 5.5, and 3.4% losses, respectively.
3/Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0=no symptoms. A correlation of r=0.82 occurred between yellows scores and sugar yield % loss.

TEST 1578: (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF RANDOM-MATING POPULATIONS
SALINAS, CALIFORNIA, 1978

Split-block with 8 replications
18 varieties and 2 virus treatments
1-row plots, 36 ft. long

Planted: February 28, 1978
Noninoculated
Harvested: October 10-12, 1978

Variety	Description	Acre Yield		Sucrose	Root Rot	Beets/ 100'
		Sugar	Beets			
		Pounds	Tons	Percent	Percent	Number
E736	Inc. E736 (C36)	12,605	41.76	15.19	0.0	127
468	Inc. 868 (US 75)	12,516	40.44	15.52	0.0	140
F70-546H3	C562HO x C546	12,097	35.89	16.96	0.0	146
7522H21	C536HO x C522	10,187	33.09	15.52	0.5	147
7740B	YRS 5740 (A,aa)	10,684	32.15	16.66	0.0	141
7741B	YRS 5741 (A,aa)	10,057	30.43	16.53	0.0	145
7742	YRS 5742 (A,aa)	10,290	31.66	16.31	0.3	148
7744	YRS C789 (A,aa)	10,326	30.83	16.79	0.4	148
7745	YRS 5745 (A,aa)	11,023	33.44	16.49	0.3	153
7755B	YRS 5755B (A,aa)	12,200	37.83	16.17	0.0	146
7789	6789aa x A	11,685	34.92	16.85	0.9	135
7790	7790aa x A	11,289	34.03	16.68	0.0	142
7796-1	6796-1aa x A	11,922	36.78	16.19	0.2	142
7796-2	6796-2aa x A	11,986	36.54	16.44	0.3	138
3791	2791aa x A	12,617	39.34	16.15	0.0	133
4791	YR/1(SY) 2791	12,505	39.28	15.99	0.3	125
4791D	YR/1(%S) 2791	12,684	38.85	16.42	0.0	136
6791	YR/2(SY) 2791	12,554	38.88	16.18	0.3	134
Mean 1/		11,624	35.90	16.28	0.2	140
LSD (.05)		1,199	3.91	0.66	NS	9.9
Coefficient of Variation (%)		10.4	11.0	3.5	364.4	7.2
F value		5.0**	6.3**	5.9**	1.0	4.7**

1/Virus treatment means were significantly different at the 1% level. A significant variety x virus interaction occurred for sugar yield at the 5% level.

TEST 1578: (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF RANDOM-MATING POPULATIONS
SALINAS, CALIFORNIA, 1978

Split-block with 8 replications
18 varieties and 2 virus treatments
1-row plots, 36 ft. long

Planted: February 28, 1978
BWYV inoculated: May 11, 1978
Harvested: October 10-12, 1978

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Yellows Scores[3]		Root	Beets/
		Inoc.	Loss[2]	Inoc.	Loss	Inoc.	Loss	6/29	7/12	Rot	100'
		Lbs/A	%	T/A	%	%	%			%	Number
E736	Inc. E736 (C36)	10,759	13.8	37.08	11.0	14.64	3.2	3.5	3.8	0.0	120
468	Inc. 868 (US 75)	9,483	23.5	33.36	17.6	14.35	7.3	5.9	7.0	0.3	121
F70-546H3	C562HO x C546	9,790	18.9	32.20	10.6	15.43	9.1	5.8	6.5	0.0	134
7522H21	C536HO x C522	8,288	18.3	28.81	12.4	14.49	6.5	5.5	6.9	0.3	138
7740B	YRS 5740 (A,aa)	9,130	14.6	28.89	10.4	15.87	4.6	4.4	5.6	0.8	128
7741B	YRS 5741 (A,aa)	8,602	13.8	27.09	10.7	15.91	3.6	4.3	5.4	0.0	129
7742	YRS 5742 (A,aa)	8,263	19.1	27.63	12.3	15.01	7.8	5.3	6.5	1.3	130
7744	YRS C789 (A,aa)	9,216	10.7	29.08	5.8	15.92	5.0	4.3	5.1	1.6	144
7745	YRS 5745 (A,aa)	9,052	17.3	29.16	12.8	15.63	5.0	4.6	5.0	0.3	132
7755B	YRS 5755B (A,aa)	9,912	18.4	33.04	13.0	15.14	6.2	5.5	6.4	0.0	138
7789	6789aa x A	9,844	15.5	31.93	9.0	15.61	7.1	4.6	5.6	0.0	125
7790	7790aa x A	9,393	16.1	30.51	9.8	15.53	6.9	5.3	5.6	0.0	128
7796-1	6796-1aa x A	10,068	14.7	33.06	9.8	15.28	5.4	4.1	4.4	0.8	127
7796-2	6796-2aa x A	9,687	18.5	32.07	11.5	15.17	7.7	5.0	4.9	0.0	120
3791	2791aa x A	10,946	12.3	36.54	6.8	15.12	5.8	4.4	5.3	0.0	121
4791	YR/1(SY) 2791	10,072	19.4	34.17	13.5	14.94	6.7	4.4	4.9	0.3	123
4791D	YR/1(%S) 2791	10,237	19.2	34.25	12.3	15.14	7.8	4.3	5.1	0.0	114
6791	YR/2(SY) 2791	10,507	15.7	34.60	10.7	15.26	5.4	4.3	5.0	0.0	128
Mean[1]		9,625	16.7	31.86	11.1	15.25	6.2	4.7	5.5	0.3	128
LSD (.05)		887.0	NS	3.23	NS	0.54	NS	0.7	0.8	0.9	13.5
Coefficient of Variation (%)		9.3	43.0	10.2	60.7	3.6	62.4	14.8	14.6	290.6	10.7
F value		6.0**	1.5	6.6**	1.2	5.8**	1.3	7.1**	9.5**	2.3**	2.4**

2/LSD (.05) for differences within varieties for different virus treatments for sugar yield was 705 lbs/A, which approximately represented a 6.1% loss.
3/Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms.

TEST 1878. PRELIMINARY EVALUATION OF LOSSES CAUSED BY BEET RUST (UROMYCES BETAE), SALINAS, CALIFORNIA, 1978

Split-plot with 8 replications
2-rust treatments
2-row plots, 75 ft. long

Planted: May 2, 1978
Sprayed: August 8 and 23, 1978
Harvested: October 23-24, 1978

Variety	Sugar Yield/A			Beet Yield/A			Sucrose			Root Rot[3/]	Beets/ 100'
	Control[1/]	No Control	Loss	Control	No Control	Loss	Control	No Control	Loss		
	Pounds	Pounds	%	Tons	Tons	%	%	%	%	%	Number
Mono-Hy D2	8,321	8,230	0.5	24.94	24.50	1.6	16.66	16.85	-1.2	0.8	134
546H3 x C36	7,769	7,999	-4.3	24.82	25.47	-4.3	15.74	15.72	0.0	0.1	135
Mean[2/]	8,045	8,114	-1.9	24.88	24.99	-1.4	16.20	16.28	-0.6	0.4	134
LSD (.05)	552	NS	NS	NS	NS	NS	0.82	0.40	NS	0.7	NS
C.V. (%)	5.8	7.3	-640.1	4.6	6.6	-850.1	4.3	2.1	-917.2	211.6	3.9
F value	5.6*	0.6	0.6	0.04	1.4	1.0	7.1*	45.4**	0.2	5.1*	0.2

1/ Rust was allowed to develop by natural infection. At incipient symptoms, control plots were sprayed with Plantvax at 3.5 lbs. ai/A on August 8 and 23. The severity of rust remained low throughout the season but from mid-September to harvest, rust incidence was relatively more severe in the uncontrolled plots. At this time there also was an obvious difference between C36H8 and Mono-Hy D2. Other than a low level of erwinia soft rot, the test appeared relatively disease free. Also see page A40, 1977 "Bluebook" Report.

2/ Rust treatments were not significantly different. Variety x rust interactions did not occur.

3/ % roots with erwinia soft rot at harvest. Diseased roots were weighed but not included in sugar sample.

Combining Ability Evaluations of Advanced Disease Resistant Inbreds

R. T. Lewellen, I. O. Skoyen, J. S. McFarlane

Inbred lines extracted from breeding populations need to be evaluated for combining ability (CA) by some efficient and systematic procedure. However, because of the limited scope of the applied breeding program at Salinas, a systematic procedure has not always been used. Traditionally we have been primarily concerned with the development of good monogerm type-O lines that possess disease resistance. Thus, relatively few advanced lines have been entered into CA tests at any one time. However, before these lines are released, some information on their CA is desirable. It also would be desirable to obtain this information prior to developing their CMS equivalents. Insufficient outcrossing has occurred with some of these $\underline{S}^f$ lines to permit the use of the standard red-beet topcross test. Therefore, the use of 3-way crosses with a common CMS line and topcross tester or pollinator, i.e., (CMS x type-O inbred) x pollinator, to evaluate CA may be technically easier and more efficient than to use single cross (type-O inbred x pollinator) evaluations.

To determine the relationship between single cross and 3-way cross performance, a set of four inbred lines and their six possible F_1 hybrids was crossed to two pollinators. The four inbreds chosen for these tests have equivalent CMS counterparts and are typical of the kinds of lines developed in the Salinas program. If epistasis is not a major factor in sugarbeet hybrid performance, then the mean of the two single crosses should be equal to their related 3-way cross; i.e., [(A x pollinator) + (B x pollinator)] /2 should be equal to (A x B) x pollinator. If deviations from this relationship do not occur, then single cross performance can be used to accurately predict 3-way cross performance for sugar yield. Conversely, if the CA performance of inbreds in a set of 3-way crosses involving a common CMS and pollinator and their common CMS x pollinator single cross is determined, then the performance of any of the possible single cross or 3-way cross combinations can be predicted. If deviations from the single cross vs. 3-way cross relationship do occur and are of sufficient magnitude, then epistasis as a factor in sugarbeet hybrid performance is suggested and the relative performance of inbred lines in hybrid combination will be more difficult to predict.

The results of the single cross and 3-way cross evaluations are given in Tests 478 and 878 from Salinas and B478 from Brawley. In addition, a summary of these tests for actual and predicted sugar yield is presented on page A37. A CA evaluation test for eight new advanced inbreds from the yellows resistance program is summarized in Test 978.

The summary on page A37 shows that the average sugar yield of the 3-way hybrids for the C17 and C31E1 pollinators were 101.6 and 102.0%, respectively, of the predicted values based on the single cross performances. For these tests, only one 3-way hybrid consistently deviated significantly. However, evidence based on hypocotyl color frequency for this hybrid, Y731H30 = (C706 x C536) x C31E1, suggested that the seed source was switched with another unknown hybrid; this deviation is probably not due to epistasis. Because of the probable lack of deviations due to epistasis, the data based on these

four inbreds suggest that 3-way crosses can be satisfactorily used to evaluate the CA of individual type-O inbreds for sugar yield. Thus a set of n inbred lines can be evaluated by n 3-way hybrids when all are crossed to a common CMS and pollinator component. Furthermore, if the performance of the single cross between the common CMS and pollinator is known, it should be possible to accurately predict the relative 3-way performance of any two of the n inbreds. For example, if the relative performance is known for

CMS x tester	= 100%
(CMS x A) x tester	= 110
(CMS x B) x "	= 105
(CMS x C) x "	= 90

then the predicted performance of

A x tester	= 120%
B x "	= 110
C x "	= 80

and the performance of the untested 3-way combinations would be predicted as

(A x B) x tester	= 115%
(A x C) x "	= 100
(B x C) x "	= 95

The CA evaluation of a moderate number of advanced inbred lines generated in the disease resistance breeding programs could be accommmodated by this type of systematic procedure. Not only would this procedure provide the necessary information on the CA of individual inbred lines, it would suggest how they would perform in various 3-way cross combinations, i.e., the type of hybrids grown commercially in California.

SUMMARY OF TESTS 478, 878, AND B478. OBSERVED AND PREDICTED 3-WAY HYBRID PERFORMANCE FOR SUGAR YIELD FROM SINGLE- AND 3-WAY CROSSES OF SUGARBEET GROWN IN 1978 AT SALINAS AND BRAWLEY, CA.

Hybrid	Test 478[1/]			Test 878			Test B478			Mean
	Obs.	Pred.	O/P[2/]	Obs.	Pred.	O/P	Obs.	Pred.	O/P	
	Pounds	Pounds	%	Pounds	Pounds	%	Pounds	Pounds	%	%
3-way hybrids with pollinator C17										
C718 x C562	11,248	11,481	98.0	12,855	12,831	100.1				99.1
C718 x C706	11,701	11,037	106.0	12,573	12,387	101.5				103.8
C718 x C536	11,809	10,955	108.0*	12,725	12,382	102.7				105.4
C562 x C706	10,825	10,760	101.0	12,410	12,073	102.8				101.9
C562 x C536	10,509	10,677	98.4	12,002	12,068	99.4				98.9
C706 x C536	10,270	10,234	100.3	11,689	11,624	100.5				100.4
Mean	11,060	10,857	101.9	12,376	11,228	101.2				101.6
3-way hybrids with pollinator C31E1										
C718 x C562	12,061	12,138	99.3	12,613	13,283	94.8	9,853	10,131	97.2	97.1
C718 x C706	12,213	12,072	101.1	12,656	12,889	98.1	10,132	10,001	101.2	100.1
C718 x C536	12,176	12,197	99.7	12,966	12,971	99.8	10,170	10,069	101.0	100.2
C562 x C706	11,397	11,170	102.0	12,144	12,299	98.7	9,246	9,370	98.7	99.8
C562 x C536	11,389	11,295	100.8	12,595	12,381	101.6	9,677	9,438	102.5	101.6
C706 x C536[3/]	12,572	11,229	111.9*	13,352	11,987	111.4*	10,784	9,308	115.8*	113.0
Mean	11,968	11,684	102.5	12,721	12,635	100.7	9,977	9,720	102.7	102.0

1/ O = observed or actual performance, P = predicted performance. Predicted performance of the 3-way hybrid, (A x B) x C, was calculated as the mean of the two corresponding single-crosses, (A x C) and (B x C).
2/ Deviation from 100% necessary for significance for specific comparisons at least at the 5% level = 7.2, 5.5, and 5.0% for tests 478, 878, and B478, respectively.
3/ Based on these field performance data and the ratio of red and green hypocotyl colors in greenhouse tests, there is some likelihood that the seed lot tested is actually a hybrid different from (C706 x C536) x C31E1.

TEST 478: COMBINING ABILITY EVALUATION OF SINGLE-CROSS AND 3-WAY HYBRIDS USING TWO TESTERS
SALINAS, CALIFORNIA, 1978

2 x 10 factorial in RCB, 8 replications
1-row plots, 30 ft. long

Planted: November 17, 1977
Harvested: September 18-19, 1978

Hybrid[1]	Female CMS x T-O		Sugar Yield/Acre x C17	Sugar Yield/Acre x C31E1	Beet Yield/Acre x C17	Beet Yield/Acre x C31E1	Sucrose x C17	Sucrose x C31E1	Bolting 9/15	Powdery Mildew	Downy Mildew	Beets/ 100'
			Pounds	Pounds	Tons	Tons	Percent	Percent	Percent	Score	Percent	Number
Single-cross hybrids												
H72	C718		11,758	13,039	41.60	44.68	14.15	14.57	1.7	4.7	1.4	165
H3	C562		11,203	11,236	38.48	36.79	14.55	15.26	1.9	5.2	1.3	162
H54	C706		10,316	11,104	35.93	36.98	14.33	15.00	1.0	4.9	1.3	164
H21	C536		10,151	11,354	35.87	38.16	14.18	14.89	0.6	5.6	0.8	146
3-way hybrids												
H31	C562	C718	11,248	12,061	39.85	40.48	14.13	14.88	3.1	4.9	1.4	154
H82	C706	C718	11,701	12,213	40.61	40.23	14.43	15.19	2.1	4.8	0.9	159
H29	C718	C536	11,809	12,176	40.70	41.72	14.54	14.63	1.2	5.3	1.7	163
H35	C562	C706	10,825	11,397	37.71	38.32	14.36	14.86	1.6	4.8	1.2	158
H28	C562	C536	10,509	11,389	36.15	38.00	14.54	14.98	0.6	5.6	0.5	164
H30	C706	C536	10,270	12,572	35.64	42.90	14.42	14.63	1.3	5.1	1.1	160
Mean[2]			10,979a	11,854b	38.25a	39.83b	14.36a	14.89b	1.5	5.1	1.2	159
LSD (.05)[3]			825		2.86		0.45		1.3	0.5	NS	8.5
C. V. (%)			7.3		7.4		3.1		120.7	14.9	140.5	7.6
F value for entries[3]			6.9**		6.2**		4.3**		2.7**	2.9**	0.6	2.2*
F value for F x M			2.2*		2.8**		1.1NS		1.5NS	1.8NS	1.6	0.9

1/Hybrid code number. In our conventional manner these 1977 seed increases would be listed as, e.g., 717H31 = (C562HO x C718) x C17 and Y731H31 = (C562HO x C718) x C31E1.

2/Means with a letter in common are not significantly different according to the F test. For bolting, powdery mildew on 7/17, and downy mildew on 4/26, the means for males are 1.4 vs. 1.6% (NS), ratings of 5.3 vs. 4.8 (**), and 1.1% vs. 1.2% (NS), respectively.

3/For bolting, powdery mildew, and downy mildew, the LSD and F values are for females.

TEST 878: COMBINING ABILITY EVALUATION OF SINGLE-CROSS AND 3-WAY HYBRIDS USING TWO TESTERS
SALINAS, CALIFORNIA, 1978

2 x 11 factorial in RCB, 8 replications
2-row plots, 30 ft. long

Planted: January 31, 1978
Harvested: September 26-28, 1978

Hybrid[1]	Female CMS x T-O		Sugar Yield/Acre x C17	Sugar Yield/Acre x C31E1	Beet Yield/Acre x C17	Beet Yield/Acre x C31E1	Sucrose x C17	Sucrose x C31E1	Root Rot	Downy Mildew	Beets/ 100'
			Pounds	Pounds	Tons	Tons	Percent	Percent	Percent	Percent	Number
Check											
H8	C562	C546	12,998	12,891	37.82	36.89	17.27	17.58	0.1	1.1	144
Single-cross hybrids											
H72	C718		13,144	13,873	40.05	41.80	16.50	16.68	0.1	3.1	142
H3	C562		12,517	12,692	37.44	36.01	16.87	17.69	0.2	1.0	145
H54	C706		11,629	11,905	34.16	33.62	17.18	17.78	0.1	3.5	147
H21	C536		11,619	12,069	35.53	35.60	16.46	17.01	0.2	1.8	139
3-way hybrids											
H31	C562	C718	12,855	12,613	38.06	37.33	16.97	16.99	0.1	3.1	139
H82	C706	C718	12,573	12,656	37.43	36.73	16.87	17.41	0.6	1.7	141
H29	C718	C536	12,725	12,966	38.60	38.56	16.56	16.91	0.2	3.0	142
H35	C562	C706	12,410	12,144	35.53	35.17	17.58	17.36	0.3	1.2	141
H28	C562	C536	12,002	12,595	35.42	36.46	17.07	17.41	0.2	2.0	140
H30	C706	C536	11,689	13,352	34.45	38.99	17.08	17.27	0.5	1.8	140
Mean[2]			12,378a	12,707b	36.77a	37.01a	16.95a	17.28b	0.2	2.1	142
LSD (.05)[3]			688		2.22		0.65		NS	1.4	NS
C. V. (%)			5.6		6.1		3.9		230.1	92.5	6.1
F value for entries [3]			5.5**		6.2**		2.6**		1.4	3.3**	1.5
F value for F x M			2.5**		2.3*		0.8NS		0.7	1.3NS	1.3

1/Hybrid code number. In our conventional manner, these 1977 seed increases would be listed as, e.g., 717H8 = (C562HO x C546) x C17 and Y731H8 = (C562HO x C546) x C31E1.

2/Means with a letter in common are not significantly different according to the F test. For root rot and downy mildew, the means for males are 0.3% vs. 0.2% (NS) and 3.3% vs. 1.0% (**), respectively.

3/For root rot and downy mildew, the LSD and F values are for females.

TEST 978: COMBINING ABILITY EVALUATION OF ADVANCED, YR, MONOGERM INBREDS, SALINAS, CA, 1978

20 varieties x 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 1, 1978
Harvested: October 2-3, 1978

Variety	Description (CMS x T-O) x Pollinator			Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Downy Mildew	Beets/ 100'
				Pounds	Tons	Percent	Percent	Percent	Number
US H10B	C562	C546	C17	13,128	40.00	16.47	0.1	1.1	142
717H72	C718		C17	13,701	42.90	16.03	0.2	5.1	131
717HL9	C718	737	C17	13,394	42.15	15.92	0.3	2.3	138
717HL11	C718	758-3	C17	13,349	40.83	16.39	0.3	2.8	134
717HL10	C718	758-1	C17	13,183	40.39	16.36	0.6	1.5	138
717HL8	C718	736	C17	13,067	41.15	15.96	0.4	1.4	133
717HL7	C718	731	C17	12,695	39.53	16.14	0.2	5.5	128
717HL13	C718	C779	C17	12,667	39.78	15.95	0.2	3.3	133
Mean of C17 hybrids[1]				13,148a	40.84a	16.15a	0.3a	2.8a	135
Y731H8	C562	C546	C31E1	12,858	38.24	16.88	0.0	0.7	137
Y731H72	C718		C31E1	13,892	42.87	16.29	0.5	0.8	133
Y731HL11	C718	758-3	C31E1	13,644	40.50	16.90	0.0	2.3	138
Y731HL9	C718	737	C31E1	13,635	41.64	16.43	0.0	0.6	133
Y731HL10	C718	758-1	C31E1	13,410	40.58	16.58	0.2	1.8	133
Y731HL8	C718	736	C31E1	13,156	39.22	16.82	0.5	0.5	122
Y731HL7	C718	731	C31E1	12,867	39.69	16.31	0.5	1.2	142
Y731HL13	C718	C779	C31E1	12,704	38.94	16.34	0.1	3.0	128
Mean of C31E1 hybrids[1]				13,271a	40.21a	16.57b	0.2a	1.4b	133
Y731HL6	C718	730	C31E1	12,863	39.70	16.28	0.2	1.3	136
Y731HL12	C718	770	C31E1	12,706	38.43	16.59	0.0	1.7	134
7758-3H37	C16		758-3	12,557	38.54	16.36	0.4	2.0	122
7758-1H37	C16		758-1	12,167	37.24	16.41	0.7	0.9	124
Grand Mean				13,082	40.12	16.37	0.3	2.0	133
LSD (.05)				739	1.90	0.60	NS	2.4	10.0
Coefficient of Variation (%)				5.7	4.8	3.7	262	121	7.6
F value				2.9**	5.0**	1.8*	0.8	2.6**	2.6**

[1] Means with a letter in common are not significantly different. For the C17 and C31E1 hybrids for which there were common females (8 females x 2 males), significant M x F interactions did not occur.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1977-78

Location: USDA-SEA, Imperial Valley Conservation Research Center

Soil type: Holtville silty clay loam

Previous crops: Cereals or fallow, 1977; Beets, 1975-6

Fertilization: Preplant: 100 lbs/A 11:48:0 and 100 lbs/A 46:0:0 (urea) broadcast and disced before listing.
Sidedress: 100 lbs/A 46:0:0.
Total (lbs/A): N(103): P_2O_5(48): K_2O(0).

Summary: 1977-8 Tests, Brawley, California

Test No.	Sowing Date 1977*	No. Entries per Test	No. Reps	No. Rows per Plot**	Plot Row Length Ft.	Harvest Date 1978	Test Design
B178	9/7	10	10	1	40	6/6	LS
B278	9/7	10	10	2	40	6/6-7	LS
B378	9/8	10	10	1	40	6/7-8	LS
B478	9/8	10	10	1	40	6/12	LS
B578	9/8	10	10	1	40	6/9	LS
B678	9/8	10	10	1	40	6/8-9	LS
B778	9/8	96	2	1	24	Observation Test	
B878	9/8	64	2	1	24	"	"
B978	9/8	10	16	1	24	Late Season Rot Test	

*Watered up starting September 9, 1977. **Rows 32" wide.

Irrigations: Sprinkled as needed to establish stand, then once following thinning. Furrow irrigated five times as needed up to May 10.

Thinned: September 30, 1977

Diseases and insects: Control measures as needed throughout growing season. Herbicides not used. Sulfur applied twice for powdery mildew control. Worms caused moderate defoliation in early May. Lannate used to control beet army worms. Virus yellows probably light. Essentially no bolting. Low incidence of root rot. At harvest a low infestation of mites was present but Empoasca infestation was moderate and causing chlorosis; variability for chlorosis suggested a differential in feeding preference or sensitivity to their toxin.

Harvest and sugar analysis: Plots were harvested with Holly's spike-wheel lifter. Roots from total plot were weighed and two six-to eight- root samples (20- to 30- pounds) removed. Sugar analyses were by Union Sugar. Root and sugar yields were adjusted for dirt and crown tare.

Remarks: Stands were consistently excellent. Test reliability should be good. No disease appeared to be severe enough at harvest to differentially reduce yields.

We wish to acknowledge the supervision of these plots by J. Robertson and C. Brown, I. V. Conservation Research Center, Brawley, CA, and Patricia Thomas, Davis, CA. for the statistical analysis.

TEST B178. IMPERIAL VALLEY HYBRID TEST, BRAWLEY, CALIFORNIA, 1977-78

10 x 10 Latin square[1]/
1-row plots, 40 ft. long, 32" beds

Planted: September 7, 1977
Harvested: June 6, 1978

Variety	Description[2]/	Acre Yield		Sucrose	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Rating
Y731HL9	6737H72 x Y631E	10,397a	37.41	13.89	131	94.5	2.9
Y731HL11	6758-3H72 x Y631E	10,154ab	35.66	14.25	141	94.2	2.9
Y731HL8	6736H72 x Y631E	10,002ab	34.52	14.49	123	94.6	2.8
Y731HL7	6731H72 x Y631E	9,810ab	34.75	14.12	144	94.1	3.1
Y731HL10	6758-1H72 x Y631E	9,721b	34.13	14.25	130	94.2	3.0
Y731HL6	6730H72 x Y631E	9,586bc	34.04	14.08	133	93.5	3.0
E736H31	3718H3 x E536	9,044cd	34.10	13.25	129	92.0	2.9
E706H31	3718H3 x E606	8,828d	33.43	13.21	115	92.7	3.1
E702H31	3718H3 x E602	8,702d	33.57	12.95	137	92.4	3.2
US H10B	546H3 x C17 (6169)	8,556d	32.10	13.34	147	91.6	3.0
Mean		9,480	34.37	13.78	133	93.4	3.0
LSD (.05)		601	1.84	0.47	16	1.05	NS
C. V. (%)		7.1	6.0	3.8	13.5	1.3	20.1
F value		9.4**	4.7**	10.6**	3.0**	9.0**	0.3 NS

1/ Missing values calculated for three plots.
2/ H72 is code for C718H0; H3 is code for C562H0; Y631E = C31E; E536 = C36; E602 = C02. Lines 6737, 6758-3, 6736, 6731, 6758-1, 6730, 3718 (= C718) are advanced monogerm inbreds from yellows resistance breeding program.

TEST B278. IMPERIAL VALLEY 546H3 X POLLINATOR HYBRID TEST, BRAWLEY, CALIFORNIA, 1977-78

10 x 10 Latin square
2-row plots, 40 ft. long, 32" beds

Planted: September 7, 1977
Harvested: June 6-7, 1978

Variety	Description[1]	Acre Yield[2] Sugar Pounds[3]	Acre Yield[2] Beets Tons	Sucrose Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating[4]
Y601H8	546H3 x Y401A (C01)	10,649a	34.85	15.28	143	95.0	2.2
Y731H8	546H3 x Y631E (C31E)	10,376ab	33.42	15.53	145	94.1	2.1
Y741H8	546H3 x Y641E	10,225b	34.72	14.73	146	94.3	2.1
Y740H8	546H3 x Y640E	9,809c	33.17	14.79	147	93.4	2.0
E706H8	546H3 x E606	9,339d	31.98	14.60	144	91.9	2.1
704-15H8	546H3 x 604-15	9,057de	30.42	14.90	143	94.5	2.1
US H10B	546H3 x C17 (6169)	8,900e	31.20	14.27	150	92.1	2.1
E736H8	546H3 x E536 (C36)	8,889e	31.42	14.13	145	92.6	2.6
E702H8	546H3 x E602 (C02)	8,816e	31.45	14.01	143	91.9	2.8
704-13H8	546H3 x 604-13	8,720e	31.19	13.98	139	94.6	2.8
Mean		9,478	32.38	14.62	144	93.4	2.3
LSD (.05)		354	0.98	0.49	NS	0.95	NS
C. V. (%)		4.2	3.4	3.8	4.4	1.1	35.9
F value		33.3**	20.2**	9.2**	1.9 NS	12.8**	1.4 NS

1/ 546H3 = C562H0 x C546
2/ Yields were adjusted to clean beet basis.
3/ Duncan's multiple-range test at 5% level.
4/ Brei nitrate rated by diphenylamine reaction (1 to 4).

TEST B37°. IMPERIAL VALLEY CURLY TOP RESISTANT HYBRID TEST, BRAWLEY, CLAIFORNIA, 1977-78

10 x 10 Latin square
1-row plots, 40 ft. long, 32" beds

Planted: September 8, 1977
Harvested: June 7-8, 1978

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Rating
717H17	5551H5 x 417 (C17)	9,529a	34.17	13.97	155	91.7	3.8
704-15H8	F70-546H3 x 604-15	9,159ab	31.67	14.47	151	94.5	3.5
717H8	F70-546H3 x 417 (C17)	9,078b	32.10	14.14	154	92.0	3.7
717H23	5551H21 x 417 (C17)	8,972b	32.31	13.89	154	92.2	3.9
704-13H8	F70-546H3 x 604-13	8,425c	30.87	13.66	157	94.6	3.9
717H24	5522-29H21 x 417 (C17)	8,206cd	30.65	13.42	152	92.6	3.7
704-15H23	5551H21 x 604-15	7,979cd	28.11	14.19	148	93.8	3.9
704-15H24	5522-29H21 x 604-15	7,875d	27.67	14.22	147	94.6	3.8
704-13H23	5551H21 x 604-13	6,970e	26.05	13.41	149	93.5	4.0
704-13H24	5522-29H21 x 604-13	6,878e	26.22	13.11	151	94.9	4.0
Mean		8,307	29.98	13.85	152	93.4	3.8
LSD (.05)		427	1.50	0.48	NS	0.81	NS
C.V. (%)		5.8	5.6	3.9	5.9	1.0	10.7
F value		35.9**	27.6**	6.5**	1.3 NS	18.0**	1.2 NS

1/ H21 is code for C536H0; H5 = C564H0; H3 = C562H0; F70-546H3 x C17 = US H10B.

TEST B478. IMPERIAL VALLEY CA EVALUATION OF SINGLE-CROSS AND 3-WAY HYBRIDS, BRAWLEY, CALIFORNIA, 1977-78

10 x 10 Latin square
1-row plots, 40 ft. long, 32" beds

Planted: September 8, 1977
Harvested: June 12, 1978

Variety	Description (CMS x T-O) x Male			Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
Y731H30	C706	C536	C31E	10,784a	33.61	16.04	125	95.9	1.1
Y731H72	C718		C31E	10,762a	33.54	16.05	128	95.9	1.0
Y731H29	C718	C536	C31E	10,170b	31.40	16.19	126	95.9	1.0
Y731H82	C706	C718	C31E	10,132b	31.44	16.12	128	95.6	1.1
Y731H31	C562	C718	C31E	9,853bc	30.15	16.37	124	96.1	1.2
Y731H28	C562	C536	C31E	9,677bcd	29.22	16.56	138	96.0	1.0
Y731H3	C562		C31E	9,500cd	28.47	16.70	133	96.2	1.0
Y731H21	C536		C31E	9,376cd	28.40	16.51	132	95.6	1.5
Y731H35	C562	C706	C31E	9,246d	28.20	16.39	133	94.9	1.2
Y731H54	C706		C31E	9,240d	28.00	16.51	138	94.5	1.3
Mean				9,874	30.24	16.34	130	95.6	1.1
LSD (.05)				496	1.35	0.40	9.4	0.83	0.3
C. V. (%)				5.6	5.0	2.8	8.1	1.0	28.3
F value				10.8**	20.2**	2.7*	2.2*	3.5**	2.1*

TEST B578. IMPERIAL VALLEY COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION: 790 PER SE, BRAWLEY, CALIFORNIA, 1977-78

10 x 10 Latin square
1-row plots, 40 ft. long, 32" beds

Planted: September 8, 1977
Harvested: June 9, 1978

Variety	Description[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
7790D	C1 Syn 1 SY by S_1 evaluation	7,634a	23.32a	16.35b	122	95.4	1.2
7790	C1 Syn 2 SY by mass sel.	7,613a	23.22a	16.40b	125	94.6	1.4
7790F	C1 Syn 1 SY by combined S_1-TX eval.	7,097ab	21.76ab	16.32b	125	96.0	1.0
4790	Source population	7,086ab	22.50ab	15.74cd	125	95.1	1.2
7790E	C1 Syn 1 SY by TX evaluation	7,072ab	22.08ab	16.05bc	128	95.1	1.5
7790J	C1 Syn 1 L%S by S_1 evaluation	6,965bc	23.30a	14.97e	127	95.3	1.7
7790C	CO Syn 1 Inc. Source through S_1	6,955bc	21.66ab	16.05bc	129	94.6	1.0
7790I	C1 Syn 1 LSY by TX evaluation	6,417cd	20.85b	15.39de	128	94.7	1.8
7790G	C1 Syn 1 %S by S_1 evaluation	6,029d	17.58c	17.19a	126	95.9	1.2
7790H	C1 Syn 1 LSY by S_1 evaluation	5,895d	18.31c	16.10bc	128	94.4	1.0
Mean		6,876	21.46	16.05	126	95.1	1.3
LSD (.05)		521	1.65	0.50	NS	0.77	0.5
C. V. (%)		8.5	8.6	3.5	7.2	0.9	41.1
F value		10.2**	11.9**	11.5**	0.5 NS	3.9**	2.8**

1/ Syn 1 populations were synthesized from remnant S_1 seed. For TX evaluations, the single-cross C718CMS x C16 was used as the common tester. Selection intensity was approximately 20% for sugar yield (SY) and for % sucrose (%S) for both high and low performance. Self-fertile S_1 plants were recombined in isolation plots by harvesting seed only from genetic male sterile (aa) segregates.

TEST B678. IMPERIAL VALLEY BROADBASE HYBRID TEST, BRAWLEY, CALIFORNIA, 1977-78

10 x 10 Latin square
1-row plots, 40 ft. long, 32" beds

Planted: September 8, 1977
Harvested: June 8-9, 1978

Variety	Description[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
[illegible]	6755H0(B) x Y631E	10,230a	31.56	16.20	140	95.5	1.9
[illegible]	[illegible] x Y631E	9,602b	30.24	15.87	139	95.4	1.7
717HL3	6755H0(B) x 417	9,576b	31.31	15.29	137	94.6	1.5
Y731HL5	6796-2H0 x Y631E	9,425b	29.04	16.22	137	95.5	1.8
Y731HL4	6796-1H0 x Y631E	9,413b	29.75	15.85	134	95.0	2.0
Y731HL2	6745H0 x Y631E	9,393b	29.22	16.08	134	95.4	1.6
US H10B	546H3 x C17 (6169)	8,834c	28.85	15.35	134	93.6	1.7
717HL1	6744H0 x 417	8,626c	28.01	15.39	140	93.7	2.0
7790EH37	Y617H0 x 5790-SY(TX)	8,125d	27.61	14.73	133	94.1	2.5
717HL2	6745H0 x 417	7,618e	25.90	14.73	134	93.0	2.0
Mean		9,084	29.15	15.57	136	94.6	1.8
LSD (.05)		468	1.30	0.46	NS	0.88	NS
C. V. (%)		5.8	5.0	3.3	5.4	1.1	44.0
F value		22.1**	13.7**	11.7**	1.4 NS	8.9**	1.2 NS

1/ Most of the "H0" parents are CMS near-equivalents of random-mating, self-fertile, monogerm populations. Line 6744H0 = C789CMS; Y617H0 = C16CMS; Y631E = C31E; 417 = C17.

IMPERIAL VALLEY EVALUATION OF U & I COMMERCIAL HYBRIDS, BRAWLEY, CALIFORNIA, 1977-78

10 replications, 4 varieties
1-row plots, 40 ft. long, 32" beds

Planted: September 8, 1977
Harvested: June 8, 1978

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Clean Beets	Nitrate Nitrogen	Bolters
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Rating	Percent
Y631H72	3718H0B x Y631E (C31E)	9,752a	33.41a	14.60a	145	95.2a	2.7ab	0 b
US H10B	546H3 x C17 (6169)	7,665b	28.33b	13.53b	143	93.3b	3.1a	0 b
U & I New	1978 Hybrid	7,163c	24.95c	14.37a	142	89.9c	1.9b	1.8b
U & I #8	CT5A x 512066	6,630d	24.26c	13.66b	146	92.7b	2.2b	32.5a
Mean		7,802	27.74	14.04	144	92.8	2.5	8.6
LSD (.05)		444	1.17	0.53	NS	1.09	0.7	4.3
C. V. (%)		6.2	4.6	4.1	8.7	1.3	31.7	54.4
F value		79.6**	106.8**	8.4**	0.2 NS	33.4**	4.5*	117.6**

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1978
By Holly Sugar Corporation (11901-1)

8 replications, 1-row plots, RCB
25 ft. long, 34-inch rows

Planted: September 12, 1978
Harvested: July 2, 1978

Variety	Description	Ext. Sugar/A	Ext. Sugar/T	Gross Sugar/A	Beets/A	Sucrose	Beets/ 100'
		Pounds	Pounds	Pounds	Tons	Percent	Number
Y522H8	(562H0 x 546) x C22	11,551	283.6	14,041	40.7	17.24	153
Y601H31	(562H0 x 718) x C01	10,680	272.5	13,205	39.1	16.86	149
Y731H31	(562H0 x 718) x C31E	10,489	287.2	12,686	36.5	17.37	154
Y741H8	(562H0 x 546) x Y641	10,436	285.2	12,661	36.6	17.30	157
Y731HL4	6796-1H0 x C31E	10,403	288.8	12,547	36.0	17.42	152
US H10B		10,346	279.8	12,659	37.0	17.12	169
E706H8	(562H0 x 546) x E606	10,276	290.5	12,369	35.4	17.48	153
Y731H8	(562H0 x 546) x C31E	10,243	281.9	12,493	36.4	17.19	163
E702H8	(562H0 x 546) x C02	10,216	284.3	12,413	35.9	17.27	167
Y523H8	(562H0 x 546) x Y423	9,967	284.6	12,102	35.0	17.28	148
E702H31	(562H0 x 718) x C02	9,883	270.1	12,279	36.6	16.78	163
Y740H8	(562H0 x 546) x Y640	9,734	278.3	11,937	35.0	17.06	160
717HL11	(718H0 x 758-3) x C17	9,241	263.1	11,610	35.1	16.54	158
717HL10	(718H0 x 758-1) x C17	8,841	261.9	11,122	33.7	16.49	155
704-15H8	(562H0 x 546) x 704-15	8,367	250.1	10,755	33.5	16.07	159
704-13H8	(562H0 x 546) x 704-13	7,813	251.7	10,012	31.0	16.13	151
704-13H24	(536H0 x 522) x 704-13	6,522	240.2	8,535	27.2	15.71	153
704-15H24	(536H0 x 522) x 704-15	6,449	244.2	8,372	26.4	15.86	152
Test Mean		9,525	272.1	11,766	34.8	16.84	157
LSD (.05)		738	9.4	842	2.6	0.33	--
Coefficient of Variation (%)		8	3.5	7	7.5	1.96	--
Standard Error of the Mean		263	3.4	301	0.9	0.12	--
F value		28.7**	23.8**	25.1**	15.3**	24.1**	--

VARIETY TEST, TRACY, CALIFORNIA, 1978
By Holly Sugar Corporation (15947)

6 replications, 2-row plots, RCB
19 ft. long, 30-inch rows

Planted: May 18, 1978
Harvested: October 30, 1978

Variety	Description	Ext. Sugar/A	Ext. Sugar/T	Gross Sugar/A	Beets/A	Sucrose	Beets/ 100'
		Pounds	Pounds	Pounds	Tons	Percent	Number
Y731H33	(718 x 546) x C31E	5,624	206.0	7,395	27.3	13.54	111
Y331H80	(564 x 718) x C31	5,442	193.9	7,325	28.0	13.06	96
E506H33	(718 x 546) x E406	5,402	182.9	7,440	29.5	12.60	102
Y731H8	(562 x 546) x C31E	5,325	206.0	7,004	25.9	13.54	104
517H12	(563 x 546) x C17	5,175	185.7	7,075	27.7	12.72	104
Y731H31	(562 x 718) x C31E	5,154	189.1	7,014	27.3	12.86	95
E706H31	(562 x 718) x E606	5,130	192.3	6,933	26.7	13.00	97
717H31	(562 x 718) x C17	4,897	192.3	6,610	25.4	12.99	112
E536H33	(718 x 546) x C36	4,855	176.8	6,784	27.4	12.36	100
US H10B	546H3 x C17	4,777	190.7	6,474	25.0	12.93	108
E736H31	(562 x 718) x C36	4,553	176.6	6,367	25.8	12.34	100
317H52	(564 x 522) x C17	4,517	176.0	6,328	25.7	12.32	86
Test Mean		5,071	189.0	6,896	26.8	12.85	101
LSD (.05)		614	10.1	766	NS	0.42	--
Coefficient of Variation (%)		10	4.6	10	9.1	2.81	--
Standard Error of the Mean		217	3.6	270	1.0	0.15	--
F value		2.67**	8.25**	2.07*	1.70	7.98**	--

DATA ON U.S.D.A. VARIETIES TESTED IN CALIFORNIA BY SPRECKELS SUGAR COMPANY, 1978

TEST AREAS:		Mendota			Woodland			Dixon			Spreckels		
Variety	Description	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar
E736H8	(F70-546H3 x C36)	3.515	28.97	12.2	4.942	36.66	13.5				4.800	42.20	11.4
E702H8	(F70-546H3 x C02)	3.581	29.78	12.0	4.788	35.52	13.5				4.977	42.41	11.7
Y731H31	(3718H3 x Y631E)	4.295	33.10	13.0	4.815	35.65	13.5				5.411	43.11	12.5
Y740H8	(F70-546H3 x Y640)	3.849	31.56	12.3	4.782	35.41	13.5				5.113	41.14	12.4
Y741H8	(F70-546H3 x Y641)	4.473	34.91	12.8	4.784	35.71	13.4				5.140	42.31	12.5
704-15H8	(F70-546H3 x 604-15)	2.905	23.94	12.2									
704-13H8	(F70-546H3 x 604-13)	2.912	25.42	11.5									
Y643H8	(546H3 x C43)							7.719	42.7	18.1			
Y644H8	(546H3 x C-32)							7.711	43.4	17.8			
Y631H8	(546H3 x C-31)							7.613	42.1	18.1			
US H9B1	(546H4 x C413)	3.096	27.08	11.7	4.861	37.31	13.0	7.544	41.7	18.1			
US H10B1	(546H4 x C817)	3.137	25.77	12.3				8.264	45.4	18.2			
GENERAL MEAN OF TEST		3.801	30.34	12.5	4.757	35.21	13.5	7.600	41.4	18.4	5.046	41.63	12.1
LSD (5%)		0.507	4.18	1.0	0.507	3.32	0.6	0.653	3.2	0.5	0.505	2.70	NS
LSD (1%)		0.671	5.53	1.4	0.670	4.39	0.8	0.866	4.3	0.6	NS	3.57	NS
S E of Mean		0.181	1.491	0.381	0.181	1.185	0.221	0.232	1.145	0.174	0.1793	0.9576	0.3430
S E in % of Mean		4.75	4.91	3.04	3.80	3.37	1.63	3.05	2.77	0.95	3.55	2.30	2.83
No. Varieties in Test			16			16			12			12	
Planting Date		April 20, 1978			April 27, 1978			May 1977			December 16, 1977		
Harvest Date		October 15, 1978			October 17, 1978			May 1978			October 10, 1978		

Comparison of S_1 and Test-cross Evaluation After One Cycle of Selection in Sugarbeet

R. T. Lewellen, I. O. Skoyen, J. S. McFarlane

When the end product of a breeding program involves hybrid cultivars, it is generally recognized that a good breeding program will have three distinctive phases: (1) development of divergent breeding populations with maximum genetic variation, (2) continuous improvement by an effective selection program, and (3) the identification of superior hybrids from the improved sources by an effective and systematic procedure. In our Salinas program, breeding populations have evolved into two broad, but not always divergent, types: (1) those possessing the $\underline{S}^f$ gene from which monogerm, type-O, seed bearing parents are to be derived and (2) those possessing self-sterility ($\underline{S}^s\underline{S}^s$) from which pollinators are to be derived. The population improvement program has largely been confined to the self-sterile sources because random mating after each cycle of selection is very difficult to obtain and control in most self-fertile sources. To overcome this problem, genetic male sterility ($\underline{a}_1\underline{a}_1$) has been introduced and relatively broadbased self-fertile, monogerm, type-O, random-mating populations have been developed. Thus, population improvement (recurrent selection) methods can be practiced in self-fertile sources and need to be evaluated. In addition, it is now feasible to use S_1 evaluation in addition to those intrapopulation improvement methods previously adaptable to self-sterile sources.

The theoretically effectiveness and efficiency of intrapopulation improvement methods have been published as have combining ability and gene action estimates in sugarbeet. However, realized progress with any breeding scheme largely depends upon the breeder's ability to identify superior genotypes. Selection methods need objective comparison for reliability in genotype evaluation. S_1 performance for genotype identification has proven effective in other crops, e.g., corn and sorghum. In an earlier study in sugarbeet (see 1976 and 1977 Reports on Sugarbeet Research), we investigated S_1 evaluation as a method of discriminating S_0 genotypes for sugar yield, sucrose percentage, and concentrations of NH_2-N, Na, and K. This is a preliminary report extending that study and compares performance and combining ability of synthetics derived after one cycle of selection. S_1 progeny evaluation is compared to test-cross progeny evaluation as a method to identify and sort genotypes for high and low performance.

Materials and Methods--The self-fertile, random-mating source population was designated 790 and was developed from bulk crosses involving a large number of self-fertile breeding lines. These inbreds had been developed in the curly top and virus yellows resistance breeding programs and were adapted to California. After a cycle of selfing and selecting for monogerm, the population was advanced by random mating. The source population segregated for genetic male sterility and S_0 plants would have been either $\underline{A}_1\underline{a}_1$ or a_1a_1.

The following generalized procedure was used to obtain the cycle 1 (C1) synthetics:

1974 CO seed planted in steckling nursery

1975 CMS tester x Aa⊗
↓ ↓
TX S_1

1976 Progeny evaluation tests at Salinas (90 corresponding S_1 and TX progenies + 10 check entries in adjacent tests)

Remnant S_1 seed planted in steckling nursery

S_1 S_1

1977 Intercross isolation plots (20% selection), seed from a_1a_1 = C1 Syn 1, fertile (A_1-) plants outcrossed to C718H0 and C16H0

1978 C1 vs. CO tests at Salinas and Brawley

After the test-cross and S_1 progeny evaluations, selections (20% intensity) were made for high and low sugar yield based on S_1 or TX performance and high and low sucrose content based only on S_1 performance. In addition, a selection based on the best combined performance of the corresponding S_1 and TX progenies for sugar yield was made. The selected S_1 families were represented by an average of 22 plants, or approximately 400 plants were intermated to form the C1 syn 1 synthetics. An unselected synthetic check was produced by intermating plants from each of the 90 S_1 families evaluated. A synthetic derived by mass selection and the original 790 source population were included in the 1978 C1 vs. CO tests. In 1977 when the selected S_1 families were being recombined, hybrids with C718H0 and C16H0 were produced. The derived synthetics and hybrids were evaluated at Salinas and Brawley in 1978.

Results and Discussion--The results of the 1978 tests at Salinas and Brawley are summarized in the following table (page A55). The results of the comparisons among the synthetics derived by S_1 and TX evaluations are presented in greater detail by individual tests in the tables identified as Tests 1278-1, -2, -3, 1678-1, -2, 2078, and B578.

Two unselected populations or synthetics were included in these tests. The entry identified as 4790 is the original source population from which the S_0 plants were randomly drawn to produce the S_1 and TX progenies. Entry 7790C is the synthetic derived by random mating among all of the 90 evaluated S_1 families and was chosen as the check entry because it represented the array of genotypes sampled from 4790 for this selection study. Entry 7790C also would be in the same state of genetic equilibrium as the other synthetics and was produced under identical field conditions. Possibly these differences may account for 4790's performance being consistently better for sugar and beet yield (about 4%) than 7790C. If increased equilibrium contributes to better population performance, then part of the apparent sugar yield increase (9.4%) attributed to mass selection (entry 7790) may have resulted from this cause. Whatever the explanation, these data show that one cycle of mass selection from spaced S_0 plants of 4790 was nearly as effective at increasing population performance as was S_1 selection.

The synthetics derived on the basis of S_1 selection for high and low sugar yield were significantly higher (11.3%) and lower (-9.8%) for sugar yield than the check. These differences were due to changes in beet yield with sucrose content remaining essentially unchanged. The selection for high sugar yield based on TX performance also produced a significant increase in sugar yield (8.5%) and beet yield (8.4%), but the selection for low sugar yield did not greatly influence the performance of the derived synthetic in comparison to the check. The synthetics for high and low sugar yield derived by S_1 evaluation were separated by about 21% difference in sugar yield performance whereas those derived by TX evaluation were separated by about 10% difference in sugar yield. Thus, the S_1 evaluation appeared to be more effective than TX evaluation at discriminating S_0 genotypes that contribute to population sugar yield. The selection based on the best combined S_1-TX progeny performance for sugar yield increased sugar yield by 6.4%.

The divergent selections for high and low sucrose content by S_1 evaluations were effective at increasing (4.2%) and decreasing (-4.0%) the sucrose content. However, these selections had an even greater influence on the root yield (-7.9 and 8.6%, respectively) so that the selection for high sucrose decreased gross sugar yield (-4.2%) and the one for low sucrose increased gross sugar yield (4.2%).

Supposedly both the S_1 and TX evaluations would identify genes for general combining ability. If so, the changes in general combining ability should be reflected in the performance of the synthetics per se and in hybrid combinations. As shown above, significant differences in the performance of the synthetics were produced by selection but such dramatic differences were not evident in the hybrid combinations tested. However, as in the performance of the synthetics per se, S_1 selection caused greater changes in hybrid performance than did TX selection. The results of these hybrid tests may be somewhat misleading and must be viewed as highly preliminary because the hybrids were produced from the fertile plants from the selected S_1 families and there had been no previous cycles of recombination.

In summary, after one cycle of selection in population 790, these preliminary results suggested that S_1 selection for sugar yield gave greater improvement in population yield than TX selection and was equal or better to TX selection for improving general combining ability. These results are consistent with those obtained with S_1 selection in population 791 which were previously reported. At least one of these synthetics will be used for additional cycles of selection to determine the practicality of using S_1 evaluation as an effective recurrent selection method for continued intra-population improvement.

SUMMARY OF RELATIVE PERFORMANCES OF C1 SYN 1 SYNTHETICS OF 790 PER SE FOR YIELD, 1978[1/]

Synthetic	Cycle[2/]	Sugar Yield (lbs/A) 1278-1	1678-1	2078	B578	Average[3/]	Beet Yield (tons/A) 1278-1	1678-1	2078	B578	Average
7790C[4/]	C0 Syn 1 Inc. source thru S_1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
4790	Original source population	102.3	105.4	105.5	101.8	103.7	102.2	104.5	105.7	103.9	104.1
7790D	C1 Syn 1 SY by S_1 eval.	107.2	113.9	114.5	109.7	111.3	108.0	113.5	115.0	107.7	111.0
7790E	C1 Syn 1 SY by TX eval.	108.5	110.1	113.8	101.6	108.5	107.1	110.0	114.6	101.9	108.4
7790F	C1 Syn 1 SY by S_1-TX eval.	108.0	109.9	105.8	102.0	106.4	106.2	107.2	106.1	100.5	105.0
7790H	C1 Syn 1 LSY by S_1 eval.	90.9	90.5	94.9	84.7	90.2	88.7	89.1	94.6	84.5	89.2
7790I	C1 Syn 1 LSY by TX eval.	98.8	99.7	101.2	92.2	98.0	100.6	101.6	103.0	96.3	100.4
7790G	C1 Syn 1 %S by S_1 eval.	97.7	101.1	97.7	86.6	95.8	94.2	96.5	96.4	81.2	92.1
7790J	C1 Syn 1 L%S by S_1 eval.	105.8	105.6	105.3	100.1	104.2	108.5	108.4	110.0	107.6	108.6
7790	C1 Syn 2 SY by mass sel.	109.9	108.9	109.3	109.4	109.4	107.6	107.2	107.6	107.2	107.4
Mean		11,405	13,544	6,471	6,876	- -	35.14	41.18	20.18	21.46	- -
LSD (.05) as %		4.9	5.6	5.5	7.6	- -	5.1	6.1	5.6	7.7	- -
C. V. (%)		5.5	5.6	6.2	8.5	- -	5.8	6.1	6.3	8.6	- -
F value		11.6**	10.8**	9.9**	10.2**	- -	12.7**	10.4**	11.2**	11.9**	- -

Synthetic	Cycle[2/]	% Sucrose 1278-1	1678-1	2078	B578	Average[3/]	SY (lbs/A) of Corresponding Hybrids 1278-2	1278-3	1678-2	Average
7790C	C0 Syn 1 Inc. source thru S_1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
4790	Original source population	100.0	101.0	99.8	98.1	99.7	- -	- -	- -	- -
7790D	C1 Syn 1 SY by S_1 eval.	99.1	100.3	99.4	101.9	100.2	105.2	102.8	103.5	103.8
7790E	C1 Syn 1 SY by TX eval.	101.4	100.2	99.3	100.0	100.2	101.9	101.5	104.2	102.5
7790F	C1 Syn 1 SY by S_1-TX eval.	101.6	102.5	99.7	101.7	101.4	96.7	103.4	104.7	101.6
7790H	C1 Syn 1 LSY by S_1 eval.	102.1	101.5	100.3	100.3	101.0	95.3	96.7	97.7	96.6
7790I	C1 Syn 1 LSY by TX eval.	98.5	98.3	98.3	95.9	97.7	102.1	99.4	99.8	100.4
7790G	C1 Syn 1 %S by S_1 eval.	103.6	104.7	101.4	107.1	104.2	95.7	100.4	98.5	98.2
7790J	C1 Syn 1 L%S by S_1 eval.	97.5	97.5	95.7	93.3	96.0	97.0	101.5	100.2	99.6
7790	C1 Syn 2 SY by mass sel.	101.9	101.6	101.6	102.2	101.8	103.9	99.9	95.9	99.9
Mean		16.30	16.47	16.04	16.05	- -	12,255	13,924	16,234	- -
LSD (.05) as %		2.5	2.5	1.4	3.1	- -	4.8	4.1	4.9	- -
C. V. (%)		2.8	2.5	1.5	3.5	- -	5.4	4.5	5.2	- -
F value		4.6**	5.4**	12.3**	11.5**	- -	23.4**	7.1**	3.9**	- -

1/Data were extracted from Tests 1278-1, -2, -3, 1678-1, -2, 2078, and B578.
2/SY, LSY, %S, L%S = selections for high and low sugar yield and high and low sucrose percentage, respectively. C1 Syn 1 = synthesis one of first selection cycle. Mass selection from spaced (28") S_0 plants.
3/Analyses of combined data were not completed when this table was prepared.
4/Synthetic 7790C was used as unselected check.

TEST 1278-1. COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION: 790 PER SE, SALINAS, CALIFORNIA, 1978

10 x 10 Latin square
1-row plots, 50 ft. long

Planted: February 1, 1978
Harvested: October 5, 1978

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
		Pounds	Tons	Percent	Number	Percent
7790	C1 Syn 2 SY by mass selection	12,184a	36.98ab	16.52ab	133	0.0
7790E	C1 Syn 1 SY by TX evaluation	12,029a	36.79ab	16.44abc	123	0.0
7790F	C1 Syn 1 SY by combined S_1-TX eval.	11,966a	36.46ab	16.48abc	134	0.0
7790D	C1 Syn 1 SY by S_1 evaluation	11,876ab	37.11a	16.06cd	124	0.0
7790J	C1 Syn 1 L%S by S_1 evaluation	11,725ab	37.27a	15.80d	106	0.0
4790	Source population	11,335bc	35.10bc	16.21bcd	116	0.0
7790C	C0 Syn 1 Inc. source through S_1	11,083c	34.35c	16.21bcd	125	0.2
7790I	C1 Syn 1 LSY by TX evaluation	10,953c	34.54c	15.97d	123	0.0
7790G	C1 Syn 1 %S by S_1 evaluation	10,827c	32.36d	16.79a	117	0.4
7790H	C1 Syn 1 LSY by S_1 evaluation	10,072d	30.48e	16.56ab	119	0.7
Mean		11,405	35.14	16.30	122	0.1
LSD (.05)		556	1.80	0.40	9.3	NS
C. V. (%)		5.5	5.8	2.8	8.6	458.7
F value		11.6**	12.7**	4.6**	6.1**	1.7

1/Syn 1 populations were synthesized from remnant S_1 seed. For TX evaluations, the single-cross C718CMS x C16 was used as the common tester. Selection intensity was approximately 20% for sugar yield (SY) and % sucrose (%S) for both high and low performance. Self-fertile S_1 plants were recombined in isolation plots by harvesting seed only from genetic male-sterile (a_1a_1) segregates.

TEST 1278-2. COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION: C718HO x 790, SALINAS, CALIFORNIA, 1978

10 x 10 Latin square
1-row plots, 50 ft. long

Planted: February 1, 1978
Harvested: October 9, 1978

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
US H10B	Lot 6169	15,221a	51.22a	14.87c	145	0.0
7790DH72	C718HO x 790-SY by S_1 evaluation	12,928b	41.05b	15.79a	134	0.0
7790H72	C718HO x 790-mass selection	12,766b	40.88bc	15.67ab	134	0.2
7790IH72	C718HO x 790-LSY by TX evaluation	12,544bc	40.27bc	15.58ab	134	0.0
7790EH72	C718HO x 790-SY by TX evaluation	12,520bc	39.72bc	15.76a	134	0.0
7790CH72	C718HO x 790-unselected source	12,286bcd	39.36bcd	15.64ab	127	0.0
7790JH72	C718HO x 790-L%S by S_1 evaluation	11,913cd	39.00cd	15.31b	131	0.4
7790FH72	C718HO x 790-SY by S_1-TX evaluation	11,876cd	37.74de	15.76a	127	0.3
7790GH72	C718HO x 790-%S by S_1 evaluation	11,753d	36.86e	15.99a	127	0.3
7790HH72	C718HO x 790-LSY by S_1 evaluation	11,710d	36.97e	15.86a	133	0.1
Mean		12,552	40.31	15.62	133	0.1
LSD (.05)		602	1.78	0.36	7.6	NS
C. V. (%)		5.4	5.0	2.6	6.4	376.0
F value		23.4**	42.6**	6.5**	4.0**	1.0

1/In the recombination isolation plots that were used to produce the first cycle synthetics (see Test 1278-1), rows of C718HO were crossed to fertile (A_1-) S_1 plants to produce these hybrids. Thus, pollinators would not have been in equilibrium.

TEST 1278-3. COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION:
C16HO x 790, SALINAS, CALIFORNIA, 1978

10 x 10 Latin square
1-row plots, 50 ft. long

Planted: February 1, 1978
Harvested: October 9-10, 1978

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
US H10B	Lot 6169	15,389a	50.83a	15.15a	146	0.4
7790FH37	C16HO x 790-SY by S_1-TX evaluation	14,308b	48.86b	14.65cd	122	0.0
7790DH37	C16HO x 790-SY by S_1 evaluation	14,227b	48.30bc	14.72bcd	123	0.9
7790EH37	C16HO x 790-SY by TX evaluation	14,051b	47.29bcd	14.87abc	129	0.2
7790JH37	C16HO x 790-L%S by S_1 evaluation	14,045b	48.36bc	14.52d	122	0.0
7790GH37	C16HO x 790-%S by S_1 evaluation	13,895bc	45.86de	15.15a	124	0.5
7790CH37	C16HO x 790-unselected source	13,838bc	46.59cde	14.86abc	118	0.3
7790H37	C16HO x 790-mass selection	13,829bc	46.67bcde	14.82bcd	123	0.2
7790IH37	C16HO x 790-LSY by TX evaluation	13,749bc	47.47bcd	14.51d	124	0.5
7790HH37	C16HO x 790-LSY by S_1 evaluation	13,374c	44.61e	14.99ab	125	0.7
Mean		14,070	47.48	14.82	126	0.4
LSD (.05)		565	1.95	0.29	7.5	NS
C. V. (%)		4.5	4.6	2.2	6.7	220.0
F value		7.1**	6.3**	5.0**	8.5**	1.3

1/See footnote 1 for Tests 1278-1 and 1278-3. Rows of C16HO were crossed to fertile (A_1-) S_1 plants. C16HO is a CMS near-equivalent of multigerm pollinator C17.

TEST 1678-1. COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION: 790 PER SE, SALINAS, CALIFORNIA, 1978

8 reps x 10 var., RCB
1-row plots, 36 ft. long

Planted: February 28, 1978
Harvested: October 12-13, 1978

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
7790D	C1 Syn 1 SY by S_1 evaluation	14,759a	45.04a	16.39bc	145	0.0
7790E	C1 Syn 1 SY by TX evaluation	14,268ab	43.64ab	16.37bcd	150	0.0
7790F	C1 Syn 1 SY by S_1-TX evaluation	14,245ab	42.53abc	16.75ab	146	0.0
7790	C1 Syn 2 SY by mass selection	14,111ab	42.51abc	16.61b	144	0.2
7790J	C1 Syn 1 L%S by S_1 evaluation	13,689bc	43.00abc	15.93d	140	0.2
4790	Source population	13,662bc	41.45bcd	16.51bc	142	0.0
7790G	C1 Syn 1 %S by S_1 evaluation	13,095c	38.30e	17.11a	147	0.3
7790C	C0 Syn 1 Inc. source through S_1	12,959c	39.67de	16.34bcd	140	0.2
7790I	C1 Syn 1 LSY by TX evaluation	12,915c	40.29cde	16.06cd	141	0.0
7790H	C1 Syn 1 LSY by S_1 evaluation	11,731d	35.36f	16.58b	141	0.8
Mean		13,544	41.18	16.47	144	0.2
LSD (.05)		764	2.50	0.41	6.1	NS
C. V. (%)		5.6	6.1	2.5	4.2	382.0
F value		10.8**	10.4**	5.4**	2.4*	1.1

1/See footnote 1 for Test 1278-1.

TEST 1678-2. COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION:
C16HO x 790, SALINAS, CALIFORNIA, 1978

8 reps x 10 var., RCB
1-row plots, 36 ft. long

Planted: February 28, 1978
Harvested: October 12-13, 1978

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
US H10B	Lot 6169	17,043a	51.25a	16.64a	160	0.0
7790FH37	C16HO x 790-SY by S_1-TX evaluation	16,913ab	51.62a	16.39a	145	0.7
7790EH37	C16HO x 790-SY by TX evaluation	16,829ab	51.34a	16.40a	145	0.5
7790DH37	C16HO x 790-SY by S_1 evaluation	16,726abc	51.43a	16.26abc	145	0.9
7790JH37	C16HO x 790-L%S by S_1 evaluation	16,183abcd	51.02ab	15.88c	144	0.2
7790CH37	C16HO x 790-unselected source	16,154abcd	49.70abc	16.26abc	144	1.5
7790IH37	C16HO x 790-LSY by TX evaluation	16,119bcd	49.46abc	16.31ab	148	2.0
7790GH37	C16HO x 790-%S by S_1 evaluation	15,911cd	48.56bc	16.40a	150	0.5
7790HH37	C16HO x 790-LSY by S_1 evaluation	15,776d	48.07c	16.41a	143	0.7
7790H37	C16HO x 790-mass selection	15,499d	48.68bc	15.93bc	147	0.3
Mean		16,315	50.11	16.29	147	0.7
LSD (.05)		801.0	2.26	0.36	5.5	NS
C. V. (%)		4.9	4.5	2.2	3.8	205.8
F value		3.5**	2.9**	3.2**	6.4**	1.3

1/See footnote 1 for Test 1278-3.

TEST 2078. COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION:
790 PER SE, SALINAS, CALIFORNIA, 1978

10 x 10 Latin square
1-row plots, 53 ft. long

Planted: May 2, 1978
Harvested: October 23, 1978

Variety	Description[1/]	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
7790D	C1 Syn 1 SY by S_1 evaluation	7,068a	22.04a	16.02cd	138	0.1
7790E	C1 Syn 1 SY by TX evaluation	7,025a	21.96a	15.99cd	138	0.3
7790	C1 Syn 2 SY by mass selection	6,746ab	20.62bc	16.37a	143	0.1
7790F	C1 Syn 1 SY by S_1-TX evaluation	6,535bc	20.32bcd	16.06cd	141	0.3
4790	Source population	6,515bc	20.26bcd	16.09c	142	0.0
7790J	C1 Syn 1 L%S by S_1 evaluation	6,501bc	21.09ab	15.41e	140	0.1
7790I	C1 Syn 1 LSY by TX evaluation	6,248cd	19.73cd	15.83d	140	0.1
7790C	C0 Syn 1 Inc. source through S_1	6,175cd	19.16de	16.11bc	140	0.3
7790G	C1 Syn 1 %S by S_1 evaluation	6,032d	18.48e	16.33ab	140	0.7
7790H	C1 Syn 1 LSY by S_1 evaluation	5,861d	18.12e	16.16abc	141	1.1
Mean		6,471	20.18	16.04	140	0.3
LSD (.05)		359	1.13	0.22	NS	NS
C. V. (%)		6.2	6.3	1.5	6.2	236.0
F value		9.9**	11.2**	12.3**	0.4	1.9

1/See footnote for Test 1278-1.

PERFORMANCE OF SUGARBEET LINES AND HYBRIDS SELECTED FOR RESISTANCE TO ERWINIA

R. T. Lewellen, E. D. Whitney, I. O. Skoyen

Breeding for resistance to soft rot of sugarbeet incited by an Erwinia was continued in 1978. Selection for resistance to soft rot was the primary objective in 15 breeding lines with concurrent selection pressure exerted for resistance to BWYV, downy mildew, powdery mildew and/or root size, shape, and sucrose content. In an additional nine breeding lines in which selection for BWYV was the primary objective, a late Erwinia inoculation was used to screen out highly soft rot susceptible genotypes. In injury-inoculation tests at Salinas and Spence, approximately 200 breeding lines and hybrids were evaluated for reaction to Erwinia.

Advanced soft rot resistant breeding lines were evaluated in hybrid combinations at Salinas, Brawley, and in cooperation with sugar company researchers. The hybrids with the C36 pollinator continued to have sugar yield performance characteristics similar to those with the C13 or C17 pollinators, e.g., US H9 and US H10 (See Tests 578, 778, 1378, B178, B278, and company tests in other sections of this report). A large semi-commercial increase of the C36H8 hybrid [C36H8 = (C562HO x C546) x C36] was produced by the California sugar companies in 1978 and is being distributed to growers with the provisional name of US H10E. Because this C36 hybrid is being produced in 1979 in larger commercial quantities and is significantly changed from either the US H9 or US H10 hybrids in its reaction to Erwinia soft rot, a new hybrid designation will be made. An official USDA-SEA-AR release is being prepared that will designate the C36 hybrid cultivar produced after 1978 as US H11. Information from recent evaluations for reaction to Erwinia is briefly summarized in the following results and discussion.

As Table 1 shows, a moderate level of susceptibility to Erwinia has always been present in California cultivars and breeding lines. However, the damaging effects of Erwinia soft rot were not recognized until after US H9 and US H10 were grown commercially. C36, selected from C13, now possesses a higher level of resistance than previously provided by US 15, 56, or 75.

TABLE 1. REACTION OF BREEDING LINES TO ERWINIA

Line	Description	% Rot/Beet	% Resist. Beets
US 15	O. P. cultivar	12	77
US 56	" "	10	83
US 75	" "	15	68
C64	Pollinator of US H7	7	85
C13	" " US H9	55	21
C17	" " US H10	51	21
C36	" " C36H8	3	94

Mean of 5 injury-inoculated tests, 1976-78.

Table 2 shows the improvement in soft rot resistance for each cycle of selection from C13 to C36. An additional (fourth) cycle of selection has been made which further reduced susceptibility.

TABLE 2. REACTION OF BREEDING LINES TO ERWINIA

Line	Description	% Rot/Beet
C13		60
E38	1 Cycle of selection	25
E38	2 Cycles of selection	15
C36	3 Cycles of selection	3
E36	4 Cycles of selection	1
E40	1 Cycle for susceptibility	84

Mean of 2 injury-inoculated tests, 1978.

One or more selections for soft rot resistance have been made in other advanced or promising breeding lines (Table 3). Two cycles of selection have reduced the susceptibility of C17 to approximately one-fourth of the unselected lines value. A third cycle of selection was made in the C17 series in 1978 as were second cycles of selection in the C31 and Y41 lines. Each cycle of selection has approximately halved the damage caused by soft rot.

TABLE 3. REACTION OF BREEDING LINES TO ERWINIA

Line	Description	% Rot/Beet
C17		52
E37	1 Cycle of selection	25
E37	2 Cycles of selection	12
C31		46
C31E	1 Cycle of selection	15
Y41		23
Y41E	1 Cycle of selection	10

Mean of 2 injury-inoculated tests, 1978.

Table 4 gives additional examples of the progress being made in selecting lines for resistance to Erwinia, particularly in combining it with other multiple disease resistant needs, e.g., curly top and virus yellows, and greater productivity.

TABLE 4. REACTION OF BREEDING LINES TO ERWINIA

Line	Description	% Rot/Beet
C17		52
C64		10
C01		19
Y40	F_2 (C17 x C64)	23
Y40E	ER (C17 x C64)	8
Y46E	ER [C17 x (C17 x C64)]	12
Y41	F_2 (C64 x C01)	23
Y41E	ER (C64 x C01)	10

Mean of 2 injury-inoculated tests, 1978.

Based upon inheritance of resistance studies and evaluation tests, it is now possible to fairly accurately predict the frequency of resistant and susceptible plants in hybrid combinations. The assumptions are that the frequency of resistant and susceptible plants in the parental lines can be accurately determined in inoculated tests, that one major host reaction gene is primarily responsible for host-plant resistance, and that this gene is completely dominant with the dominant allele conditioning a high level of resistance. Examples are provided in Table 5 in which parental lines are represented by R (resistant), I (intermediate), and S (susceptible) types. The R, I, and S values used are those observed from the evaluation of parental lines C36, 546H3, and C17, respectively.

TABLE 5. THEORETICAL FREQUENCY (%) OF SUSCEPTIBLE PLANTS IN HYBRID COMBINATIONS

Seed Parent	Pollinator R	Pollinator I	Pollinator S
R	4	10	20
I	10*	30	50**
S	20	50	80

Values based on injury-inoculated tests at Salinas.

R = 4% susceptible plants, e.g., C36
I = 30% " " , e.g., 546H3
S = 80% " " , e.g., C17

* I x R = 10% susceptible plants is close to observed value for C36H8.
** I x S = 50% susceptible plants is close to observed value for US H10B.

For example, the R line has about 4% susceptible plants. The frequency of the recessive allele is then the square root of 0.04 or 0.2. Likewise, the frequencies of the susceptible or recessive allele for the I and S lines are approximately 0.5 and 0.9, respectively. The proportion of susceptible plants from any combination of these lines is then the product of their recessive gene frequencies. For example, two resistant lines equal to C36 would have 0.2 x 0.2 x 100 or approximately 4% susceptible plants. The R x I hybrid combination would have 0.2 x 0.5 x 100 or approximately 10% susceptible plants which is very close to the observed value for the C36H8 hybrid [C36H8 = 546H3(I) x C36(R)]. An I x S combination would have 0.5 x 0.9 x 100 or about 50% susceptible plants which is very close to the observed value for the US H10B hybrid [US H10B = 546H3(I) x C17(S)]. A similar procedure can be used to estimate the frequency of susceptible plants in any hybrid. It should be pointed out, however, that this procedure estimates the frequency (%) of susceptible plants and not the DI or % rot/beet value usually used to compare varietal reactions and damage estimates. Normally the DI or % rot/beet value will be about half the value of the % susceptible roots.

EVALUATION OF HYBRIDS AND BREEDING LINES TO ERWINIA ROOT ROT, 1978

Variety	Description	Test 1778. Spence[1] DI[3]	% Resistant[4]	No. of Roots	Salinas, 1978[2] DI	% Resistant	No. of Roots
HYBRIDS:							
464H8	(562H0 x 546) x F66-64	13.4	75.7	74	9.8	81.0	105
US H9B	" x C13(9034)	23.8	55.9	69	24.5	53.8	93
US H10B	" x C17(6169)	29.5	53.7	67	17.0	67.3	104
E536H8	" x C36	5.6	91.5	71	3.0	95.2	105
E736H8	" x C36	2.3	95.8	71	2.1	96.3	109
704-13H8	" x 604-13	18.5	66.2	71			
704-15H8	" x 604-15	16.1	68.4	57			
E702H8	" x C02	5.5	93.8	65	5.6	88.2	102
E706H8	" x E606	3.2	93.3	60	6.3	89.7	107
E506H8	" x E406	8.6	84.4	64			
517TH29	(718H0 x 536) x 117T	51.4	33.3	63	52.2	20.6	97
417TH8	(562H0 x 546) x 117T	49.5	30.5	59			
Y601H8	" x C01	9.8	81.7	71			
Y631H8	" x C31	11.0	81.4	70			
Y731H8	" x C31E1	12.0	82.9	70			
Y740H8	" x Y640	4.4	94.7	76			
Y741H8	" x Y641	6.6	88.7	71			
Y746H8	" x Y646	4.8	90.7	75			
717H8	" x C17	22.9	61.4	70			
717H24	(536H0 x 522) x C17	25.6	58.8	80	32.8	40.6	101
704-13H24	" x 604-13	27.4	59.2	71			
704-15H24	" x 604-15	32.1	50.7	69			
717H31	(562H0 x 718) x C17	33.0	43.1	65	33.4	38.8	103
E702H31	" x C02	15.7	71.2	59	9.2	81.8	99
E706H31	" x E606	8.4	88.4	69	5.7	89.1	101
E736H31	" x C36	4.5	90.6	64	4.5	93.1	101
Y601H31	" x C01	20.2	67.2	67			
Y631H31	" x C31	28.0	61.8	68	33.8	44.1	102
Y731H31	" x C31E1	17.6	75.3	73	15.7	69.7	99
Y731H3	F66-562H0 x C31E1	14.0	72.6	73			
Y731H4	F67-563H0 x C31E1	20.2	66.7	69			
Y731H21	C536H0 x C31E1	14.3	70.3	74			

1/ Test 1778 at Spence Field. 1-row plots, 25 ft. long, 2 replications. Planted May 4, 1978. Injury-inoculated July 19, 1978. Harvested and scored November 6-7, 1978.

2/ Test at Salinas. 1-row plots, 20 ft. long, 1, 2, or 4 replications. Planted May 10, 1978. Injury-inoculated July 19, 1978. Harvested and scored October 3-4, 1978.

3/ DI = Disease Index = Σ % rot/no. of roots. Roots scored on a scale of 0, 1(VN), 7, 25, 50, 75, 93, and 100% rot.

4/ Roots with scores of 0 to 7% rot were considered resistant.

Variety	Description	Test 1778. Spence[1/] DI	% Resistant	No. of Roots	Salinas, 1978[2/] DI	% Resistant	No. of Roots
Y731H54	C706HO x C31E1	23.8	63.6	66			
Y731H72	C718HO x C31E1	25.9	63.8	58			
Y731HL4	6796-1HO x C31E1	23.4	64.6	65			
Y731HL5	6796-2HO x C31E1	26.0	64.3	70			
Y731HL6	(718HO x 730) x C31E1	33.6	53.5	71			
Y731HL7	(" x 731) x C31E1	17.2	74.3	74			
Y731HL13	(" x 779) x C31E1	22.2	63.9	61			
SELF-STERILE LINES:							
Y723	YRS Y523	14.1	81.5	65	15.4	69.2	104
Y726	YRS Y526	13.5	81.7	60	16.2	76.6	107
Y730	YRS Y430	29.5	55.2	67			
468	Inc. 868(US 75)	22.6	62.9	62	14.2	76.4	110
Y743(C43)	ERS 5202	8.8	82.4	68	10.4	84.6	26
Y744A(C32)	ERS 4247	13.0	82.9	70	4.3	89.3	28
Y744B(C32)	ERS 3209	6.9	84.1	63			
704-13	Inc. 604-13	13.6	75.4	61	11.9	77.1	48
704-15	Inc. 604-15	29.3	51.0	51	18.5	60.8	51
F77-02	Inc. C02	13.2	82.2	45	5.2	91.3	103
E702(Iso)	ERS E402	7.5	91.8	49	2.6	97.1	105
E702	Inc. E602(C02)	7.8	90.2	51	4.3	94.0	100
E702(MS)	Seed from MS plts.	3.4	93.2	59			
F77-36	Inc. C36 (7322)	3.4	94.8	58	3.0	92.2	102
E736(Iso)	ERS C36	1.0	98.0	51	1.2	98.1	107
E736	Inc. C36	3.6	96.3	54	1.6	97.9	96
E736(MS)	Seed from MS plts.	2.5	96.2	53	2.0	96.9	96
E536(Sp)	C36	3.9	96.2	52	1.7	97.8	92
517T	Inc. C17T	81.2	5.7	53	66.6	21.2	104
Y717	Inc. C16	48.6	39.6	53			
Y717HO	C16HO x C16	55.1	35.4	48			
E706	Inc. E606	3.8	94.6	74	4.9	91.6	95
E706(MS)	Seed from MS plts.	4.5	93.5	77			
E506(Sp)	Inc. E406-#'s	1.0	97.3	75	2.8	94.6	93
F77-23	Inc. C23	21.1	68.4	79	27.5	57.7	104
417(Ore)	Inc. C17	47.8	35.5	96	56.7	24.8	109
E637	Inc. E537(C17E1)	17.0	73.2	71	33.3	52.0	100
E737	ERS E537(C17E2)	6.2	91.3	80	17.8	76.7	103
F70-13	Inc. F66-13(0268)	54.1	28.4	74	64.9	18.7	107
E638	Inc. E538(C13E1)	31.8	63.2	76	18.9	67.3	101
E738	ERS E538(C13E2)	4.9	93.7	79	10.2	82.2	101
E640	ESS E540	79.0	13.7	73	89.2	1.0	105
7747	6219,20,21aa x E-#'s	11.7	83.3	72			
464	Inc. F66-64	12.8	82.4	68	6.2	90.3	103
Y440	Inc. 3254	29.4	56.5	62	15.8	71.2	59
Y740	Inc. Y640(Y40E1)	8.0	86.6	67	7.9	81.0	42
Y441	Inc. 3255	18.6	73.1	67	26.8	53.8	52
Y741	Inc. Y641(Y41E1)	8.8	88.5	61	11.8	80.4	46
Y746	Inc. Y646(Y46E1)	11.0	77.1	70	13.8	77.1	105
Y601	Inc. C01	18.5	76.3	59			

Variety	Description	Test 1778. Spence[1] DI	% Resistant	No. of Roots	Salinas, 1978[2] DI	% Resistant	No. of Roots
Y631	Inc. C31	44.9	45.9	61	46.7	32.7	107
Y731	Inc. C31E1	14.1	79.3	58	15.1	74.7	99
SELF-FERTILE, RANDOM-MATING LINES:							
7748	6796-1,-2aa x E-#'s	22.5	68.7	67			
7796-1	6796-1aa x A	35.7	43.7	71			
7796-2	6796-2aa x A	21.5	71.4	63			
4789	3789aa x A	32.0	54.7	53			
7789	6789aa x A	32.6	60.4	48	15.9	69.2	52
7744	YRS C789	37.7	48.4	64	24.8	58.5	53
7740B	YRS 5740(A,aa)	40.0	45.2	62			
7740	T-O Sel. 6740aa x A	29.6	57.6	66			
4790	3790aa x A	25.9	65.5	58			
7790	6790aa x A	5.2	91.7	60	2.2	96.2	52
7790C	5790-CO(S_1)aa x A	30.9	58.0	50			
7790D	5790-SY(S_1)aa x A	23.4	63.9	61			
7745	YRS 5745 (A,aa)	26.3	59.1	66	28.5	57.7	52
7741B	YRS 5741(A,aa)	39.9	41.7	60			
7741	T-O Sel. 6741aa x A	31.1	50.0	48			
7742	YRS 5742 (A,aa)	28.8	58.3	60			
7755B	YRS 5755B (A,aa)	25.9	69.6	69			
7755	6755aa x A	37.2	53.1	64			
F_1 HYBRIDS:							
3718H3(Sp)	F66-562HO x 718	28.6	57.4	61	8.9	80.4	56
3705H3	" x 706	16.6	75.0	76			
3536-97H3	" x 536	21.9	64.1	64			
3718H54	706HO x 718	23.8	55.8	77			
3536-97H54	" x 536	29.8	59.4	69			
3536-97H72	718HO x 536	33.0	49.2	59			
7730H72	718HO x 6730	41.9	40.3	72			
7758-1H72	" x 6758-1	31.2	63.0	73			
7758-3H72	" x 6758-3	55.2	29.3	58			
3546H72B	718HO x F70-546	14.8	79.4	68			
F70-546H3	562HO x 546 (0036)	15.6	76.1	67	3.5	92.5	53
F69-546H4	563HO x 546 (9056)	8.8	81.4	59			
5522-29H21	536HO x 522	30.8	53.1	64			
7522H21	536HO x 522	31.2	49.2	65	11.3	71.2	52
SELF-FERTILE LINES:							
7522	Inc. 522	24.3	72.4	58			
7522HO	522HO x 522	40.4	51.6	64			
4536-97HO	536HO x 536	32.9	41.5	65			
F70-546	Inc. 546 (0139)	11.2	80.4	46	4.7	7.5	24
7546E	ERS F70-546	5.3	89.2	65	3.2	3	26
7758-1	Inc. 6758-1	56.6	35.5	62	29.5	1	28
7758-3	Inc. 6758-3	63.9	19.6	51	34.6	9	27
F66-562	Inc. 562 (6618)	46.0	37.7	69	25.1	7	26

Variety	Description	Test 1778. Spence[1] DI	% Resistant	No. of Roots	Salinas, 1978[2] DI	% Resistant	No. of Roots
7562E	ERS F66-562	17.5	66.7	63	6.7	81.5	27
F66-562HO	562HO x 562 (6349)	18.0	59.3	27			
7562EHO	ERS (562HO x 562)	5.4	84.0	25			
F67-563	Inc. 563 (7433)	43.9	34.2	79	25.4	48.1	27
7563E	ERS F67-563	39.1	46.3	67	10.1	70.0	30
F67-563HO	563HO x 563 (7432)	24.0	57.7	26			
7563EHO	ERS (563HO x 563)	13.5	63.6	22			
3705	Inc. 706	37.8	49.3	67	13.1	74.1	27
7705	ERS 706	24.1	56.2	73	7.8	88.0	25
7705HO	ERS (705HO x 705)	28.3	52.5	80			
F71-705	Inc.705 (1279)	40.6	44.4	72			
3718 (Sp)	Inc. 718	35.7	42.5	73			
F74-718	Inc. 718 (4170)	39.6	31.5	73			
7717	NBS 4232	29.3	60.3	68	17.8	68.2	22
6719	ERS 4717	5.7	90.6	64	3.8	95.2	31
7730	Inc. 6730	74.0	14.7	75			
7731	Inc. 6731	42.2	39.2	74			
7778	Inc. 5778	31.7	52.1	71			
7779	C779	23.0	62.2	74			
7203	6217 (bmbm)⊗	21.0	63.8	58			
7204	6217 (BmBm)⊗	18.9	65.7	67			
7205	6211 (bmbm)⊗	59.6	24.3	74			
7206	6211 (Bmbm)⊗	49.5	24.7	77			
7207	6212 (bmbm)⊗	63.4	23.2	69			
7208	6212 (BmBm)⊗	39.7	43.4	76			
7211	6215 (bmbm)⊗	41.7	44.6	65			
7212	6215 (BmBm)⊗	25.8	59.4	64			

Notes on Erwinia soft rot evaluations at Salinas and Spence:

The conditions for the Salinas test were superior to those for the Spence test (Test 1778) and should have better reliability. Test 1778 was grown on a variable plot of soil and differential growth rates are known to influence the severity of soft rot. In addition, downy mildew infection in Test 1778 was moderate in susceptible lines and it was sometimes difficult to distinguish the systemic symptoms of these two diseases.

The entry E640 should be nearly 100% susceptible to Erwinia. At Salinas, 1% of the plants were scored as resistant. At Spence, about 14% of the plants were scored as resistant, suggesting a higher frequency of escapes.

Erwinia soft rot development is known to be more severe under high temperatures. Therefore, it is probable that under the warmer conditions of California's interior valleys, the rot ratings would be higher.

In comparison with vigorous O.P. lines or hybrids, inbred lines may not give true disease ratings. Growth rates, whether due to environmental or genotypic causes, appear to influence rate of rot development. Thus, inbreds are probably scored as being more resistant than they actually are. Monogerm lines also are difficult to accurately score. If a resistant monogerm plant's apex is too severely damaged by injury-inoculation, the root will appear to be too severely damaged by Erwinia infection.

FUSARIUM STALK BLIGHT RESISTANCE TEST
Salem, Oregon, 1977-78

Entry	Description	Grade[1/]
6536-4	Fus. res. sel. 4536-97	0
6505-32	Fus. res. sel. F_2(563 x 502)	0
6563-40	Fus. res. sel. F67-563	.02
6505-98	Fus. res. sel. F_2(563 x 502)	.04
F70-13	Pollinator for US H9	.07
7554	Inc. NB4 inbred	.08
6564H1	(502H0 x 563) x 4564C1	.09
6554 Iso.	Inc. NB4 inbred	.10
7502	Inc. S_{20} NB1 inbred	.17
6563-30	Fus. res. sel. F67-563	.20
F69-546H5	564H0 x F66-546	.24
7563	Inc. S_{14} 563 inbred	.31
F70-546	mm inbred	.33
6522-29	CTR inbred	.35
704-23	CTR Y804	.36
5522-29H1	3536-97H0 x 4522-29	.45
1502H0	CMS of NB1	.47
704-9	CTR Y804	.62
5522-29H0	CMS of 6522-29	.64
5551H5	F67-564H0 x 8551	.72
F66-562	mm inbred	.78
7533	(563aa x 502Aa) x 4564C1	.81
1502	NB1 inbred	.86
F67-563H0	CMS of 563	1.00
F67-569H3	562H0 x 569	1.02
704-13	CTR Y804	1.04
5551	mm inbred	1.21
4536-97	CTR inbred	1.30
F67-563	mm inbred	1.35
704-15	CTR Y804	1.41
4564aa	1564aa x 3565Aa	2.06
6564H0	4564H0 x 5564	3.09
5564Aa	4564aa x 4564C1	3.27
3565	mm inbred	3.38
6562	Inc. S_{13} 562 inbred	3.60
5564	mm inbred	3.62

1/ Stalk blight rated on a scale of 0 to 4 with 0 = no disease and 4 = dead plant.

INTERSPECIFIC HYBRIDIZATION

Studies of Interspecific Hybridization in *Beta* Species

M. H. Yu

Transmission of Nematode Resistant Factor from the Alien Monosomic Addition Lines of Sugarbeet

During the past years a series of screening and selection had been conducted with the objective of transferring the nematode resistant factor from the wild beet, *Beta procumbens*, into sugarbeet via interspecific hybridization. The available alien monosomic addition sugarbeet lines with the resistance, which had been irradiated once or twice and backcrossed for eight generations by Dr. H. Savitsky, were used as maternal parent, pollinator, or both in this study. Portions of those plant materials were irradiated with gamma-rays on the inflorescence at various developmental stages between initiation of floral buds and the beginning of anthesis, with dosages ranging from 700 to 1,900 roentgen for group A plants and 2,000 to 2,800 roentgen for group B.

The rate of nematode resistant transmission was rather low in all occasions. Most of the resistant progeny contained 19 chromosomes, with an average frequency of 10.52% through ovules (Table 1). The probable pollen (with 10 chromosomes) transmitted 19-chromosome resistant progeny was obtained at 0.025% rate. The 19-chromosome pollen parent of this plant was irradiated with gamma-rays 1,000 r at the time of first anthesis.

The irradiated pollen (1,300 r, just prior to anthesis) also resulted in one diploid resistant progeny among the 1,850 plants examined. However, this diploid plant did not grow vigorously. The other two diploid resistant plants were isolated from untreated parents. One of them carried an annual bolting characteristic. Thus the average frequency of identifying nematode resistant diploid sugarbeet from progeny of the resistant 19-chromosome plants was approximately 0.046%, based on the observation of 6,580 plants.

Performance Among the Progenies of a Diploid Nematode Resistant Sugarbeet

The diploid nematode resistant sugarbeet, selection 51501, was recovered from 2,500 plants of self-sterile resistant alien monosomic addition lines that were grown and interpollinated in an isolated field plot in 1975. The rate of nematode resistant transmission was estimated to be 13.3%. The resistant progeny were crossed to diploid nematode susceptible plants to further examine the resistance inheritance. The results in Table 2 showed that the overall nematode resistance transmission rate remained the same as that of the original 51501. However, the transmission frequencies vary from 5.3% to 21.4% based on the moderate numbers of progeny plants screened. Whether the divergence had been caused simply by sample error or other reasons was unknown. It seemed that the pollen transmitted resistance did not bring together a significantly improved genotypical composition, since only 1% increment of transmission rate was demonstrated in the C17/51501 group (Table 2).

Meiotic behavior of selection 51501 was not normal, including the formation of two dicentric bridges at approximately 1.25% frequency in both the first and second meiosis. Whether the structural aberration of those chromosomes had any interrelation with the nematode resistance was not known. Cytological examination of the progeny plants showed that both the resistant and susceptible progenies contained the same category of structurally aberrant chromosomes (Table 3). If nematode resistance was associated with one (or more) rearranged chromosome(s) then the resistant progeny plants should form at least one bridge theoretically, and the susceptible progeny should carry no more than one bridge. In this study, however, one susceptible progeny with two bridges and one resistant plant with no bridge had been observed from the 29 progeny plants investigated (Table 3). Therefore, unless crossing-overs involving the chromosome segments that carried the resistant factor had occurred, the transmission of nematode resistant factor might be actually independent from the bridge formation mechanism(s).

One nematode resistant plant, selection 61202, derived from 51501 was triploid, 2n=27. This triploid resistant plant was transplanted into an isolation chamber together with one self-sterile, nematode susceptible diploid plant of line C17. Both plants grew vigorously and produced numerous flower branches. Sample microsporocytes of 61202 were collected for cytological examination. The chromosomal distribution of this plant at anaphase I was in close agreement to the theoretical distribution (Table 4). However, there were some 20% of pollen mother cells proceeding abnormal meiotic behavior, which was not the case for the control normal triploid sugarbeets, i.e., less than 2% abnormalities.

Progeny of plant 61202 has been partially investigated. Plants with chromosome numbers of 18, 19, 20, 26, and 27 were found. None of the single chromosome number groups were classifiable as totally nematode resistant. Many seeds failed to germinate, and several seedlings grew abnormally and died at an early stage. If 61202 were derived from a diploid egg and carried two doses of nematode resistant factor, then all the 27-chromosome progeny plants would likely be resistant. The resistance transmission phenomenon observed in this plant might have occurred from one of the following possibilities: a) the original diploid megaspore was developed from a first meiotic division restitution nucleus, b) chromatid segregation, or double reduction, had taken place during meiosis of the megasporocytes, c) a multigenic controlling system was involved in the production of nematode resistance, or d) a haploid egg of 61202 was fertilized by a diploid pollen grain from the susceptible pollinator.

Table 1. Inheritance of nematode resistant factor of the resistant alien monosomic addition sugarbeet lines.

Type of NR Progeny	NR Source	# Progeny Tested	# NR Progeny	%
18 chromosomes	Pollen, irradiated	1,850	1	0.054
	Pollen, untreated	2,230	1	0.045
	Intercrossed, untreated	2,500	1	0.040
		6,580	3	0.046
19 chromosomes	Ovule, irradiated (A)	4,424	437	9.88
	Ovule, irradiated (B)	1,262	172	13.63
	Ovule, untreated	1,474	191	12.96
	Intercrossed, untreated	2,499	216	8.64
		9,659	1,016	10.52
	Pollen, with/without treatments	4,080	1	0.025

Table 2. Frequency of nematode resistance transmission of the progeny of line 51501, crossed by nematode susceptible pollinators.

Source	Code No.	# Plants Tested	# NR Plants	%
51501/C17	1	83	12	14.45
	2	75	4	5.33
	3	81	8	9.88
	4	124	22	17.74
	5	100	13	13.00
	6	113	12	10.62
	7	77	10	12.98
	8	100	19	19.00
	9	84	18	21.43
	14	89	15	16.85
	15	72	10	13.89
	16	87	11	12.64
	17	166	14	8.43
	18	85	14	16.47
	19	147	15	10.20
	20	89	8	8.99
	21	179	25	13.97
	22	18	1	5.55
	23	54	8	14.81
	24	62	4	6.45
	25	131	14	10.69
	26	84	16	19.05
	27	135	21	15.56
		2,235	294	13.15
C17/51501	10	89	15	16.85
	11	90	13	14.44
	12	88	15	17.05
	13	90	16	17.78
	28	60	5	8.33
	29	120	14	11.67
	30	38	4	10.53
		575	82	14.26
Total		2,810	376	13.38

Table 3. Appearance of meiotic bridges in the progenies of nematode resistant sugarbeet 51501.

Type of Progeny	No Bridge	1 Bridge	2 Bridges
Resistant (16)	1	13	2
Susceptible (13)	2	10	1

Table 4. Chromosome distribution of plant 61202 and normal triploid sugarbeet at anaphase I.

Distribution	61202		Normal 3x	
	Obs.	Theor.	Obs.	Theor.
18-9	3	1	4	1
17-10	8	8	15	10
16-11	34	33	42	42
15-12	71	76	101	97
14-13	117	115	133	145
	(233)	(233)	(295)	(295)
Others	61 (20.8%)		5 (1.7%)	
Total	294		300	

INTERSPECIFIC HYBRIDIZATION

VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

The diploid nematode-resistant plants have well developed foliage, good roots and cannot be distinguished from normal sugarbeets. No characters peculiar to B. procumbens that are caused by deleterious genes of the wild species have been observed in diploid nematode-resistant plants. However, the rate of resistance transmission is not yet sufficient for incorporation into commercial varieties. The inadequate rate of resistance transmission is caused by insufficient association of the B. procumbens segment with the B. vulgaris chromosome in meiosis of nematode resistant plants.

A study of nematode-resistance transmission indicated that resistance is transmitted by female gametes (average transmission 24%) and by male gametes at lower frequency (average transmission 12%). Transmission of resistance by pollen enables the development of homozygous nematode-resistant lines. Obtaining these lines is important because all offspring of homozygous plants will be resistant due to more normal meiosis. The development of resistant varieties will thereby be facilitated.

Work in 1978 was concentrated on the development of homozygous resistant lines and on experiments destined to increase the transmission of cross-overs of the B. vulgaris chromosome bearing the B. procumbens segment. To obtain self-fertile homozygous lines, the nematode-resistant plants were crossed with inbreds. The F_1 resistant plants were selected and selfed. In 32 self-fertile F_2 progenies 1,920 plants are being tested for resistance. The individual F_2 lines differed in the rate of resistance transmission. The occurrence of resistant plants varied from 14 to 41 percent. Several F_2 lines had high transmission rates varying from 29.4 to 41 percent.

To obtain self-sterile homozygous lines the resistant F_3 plants were intercrossed, and the F_4 progenies of 33 F_3 plants were tested for resistance. The number of tested self-sterile F_4 plants was 1,850. Transmission rates of resistance varied in the individual F_4 populations from 10 to 40 percent. The number of resistant plants was high in some F_4 populations, reaching 36.4 and 40 percent. In F_1 hybrids derived from hybridization of nematode-resistant and nematode-susceptible plants only rare plants transmitted resistance at the 27-30 percent rate.

A considerable increase in the percent resistant plants in the progenies of self-fertile and self-sterile hybrids derived from mutual transmission by female and male gametes indicates that such material should be used for development of homozygous plants. Self-sterile and self-fertile lines with the highest transmission rates were selected to increase the transmission of nematode resistance and for the development of homozygous nematode-resistant lines in succeeding generations.

To facilitate the transmission of the B. vulgaris chromosome bearing the B. procumbens segment the 22 self-fertile and 24 self-sterile nematode-resistant plants were irradiated at the Lawrence Irradiation Laboratory of the University of California to decrease the size of B. procumbens segment. Their progenies will be tested for resistance. To increase transmission of resistance by pollen, 1,630 plants obtained from pollen transmission during two generations were tested for resistance. A few plants with pollen transmission reaching 19 and 22 percent were selected. The cytological study of diploid nematode-resistant hybrids included the study of meiosis and the determination of chromosome numbers in selected plants.

VULGARIS-COROLLIFLORA HYBRIDS

Because of the very low transmission of curly top resistance in hybrids described in previous reports the following methods were applied. Repeated selections for curly top resistance were made in the old hybrids possessing 27 chromosomes. Ten highly resistant plants were selected in the progenies of these plants after inoculation with a virulent strain of curly top virus. In order to obtain hybrids in which curly top resistance is derived only from B. corolliflora, the tetraploid plants of the highly curly-top susceptible sugarbeet line 742 are being produced for use in hybridization with B. corolliflora. This work is conducted in cooperation with Dr. McFarlane.

Field Evaluation of Root Toughness in Sugarbeet

I. O. Skoyen and R. T. Lewellen

The 1978 field studies on root toughness (fiber content of roots) were similar to the preliminary study reported in 1977 ("Sugarbeet Research" - 1977 Report, pages A77-A80). The evaluation of environmental effects on root toughness was emphasized in two 1978 tests seeded at different dates and root selections for both high and low fiber content in a third test were emphasized.

Materials and Methods--Two tests, each with the same 24 entries, were seeded November 16, 1977 and February 1, 1978, respectively. The tests included representative multigerm and monogerm inbred lines, F_1 hybrids, open-pollinated lines, and hybrid varieties developed at the U.S. Agricultural Research Station, Salinas, California. A third test of 12 entries was seeded May 2, 1978. Root toughness was measured on a single plant basis as lbs. pressure required for a blade to penetrate a root 2.54 cm deep. Measurements were made in half pound increments. Root probes were made 1 to 2 inches below the crown and horizontally to the vertical plane of the roots.

The modified Magness-Taylor pressure tester used in 1977 was replaced with an Effegi penetrometer in 1978. The same blade used in 1977 toughness measurements was used for tests 1 and 2 in 1978. Dimensions of the blade were 1 x 15.75 mm (15.75 mm cross section) x 2.54 cm long. For test 3, the blade used measured 1 mm x 1 cm (10 sq mm cross section) x 2.54 cm long. The dial of the Effegi penetrometer has a graduated dial capacity of 27 foot lbs. pressure but it can be readily interpreted up to 28 foot lbs. The 28 lb. toughness measurement has been included in the test results.

Results and Discussion--As was demonstrated in 1977, the mean root toughness among the different types of lines represented in the tests in 1978 appeared to occur at random (Tables 1 and 2). Inbred lines and F_1 hybrids tended to have higher mean root toughness than open-pollinated lines and 3-way hybrids (Table 1).

Arranging toughness measurements into frequency classes showed that a broad range of toughness (apparent root fiber content) within lines also occurred in 1978 (Tables 1 and 2). The pounds pressure required for the blade to penetrate the roots were also higher in 1978. Combining the 12- to 22-lb. pressure frequency classes showed that this portion of the distribution accounted for 57% of the roots for the "softest" variety and as low as 11% for the toughest (Table 1). These values were 30% lower than those for 1977. This reduction was probably due to: (1) the Magness-Taylor probe underestimated root toughness (it was more difficult to keep in calibration than the Effegi) and (2) beets were tougher in 1978 than in 1977.

In test 3, root toughness comparisons were made between five topcross pollinators and their 3-way hybrids (Table 2). The mean probe values show that there were toughness differences between hybrid and pollinator only for Y601 and Y740 with the hybrid having the toughest roots in both instances. Both the late seeding date and the narrower probe blade used for test 3

probably contributed to the lower root toughness values compared with those of tests 1 and 2. Selections for both high and low fiber content based on probe values were made in test 3. Progeny of the selections will be evaluated to determine the potential for change in root toughness in sugarbeet populations.

So far the sugarbeet populations tested for root toughness (root fiber content) have all had a number of roots that the probe penetrated only at pressures beyond the scale of the probe or were not penetrated at all. More of these "extra tough" roots were generally found as test plants increased in age. The mean percentage of plants with roots requiring over 28 lbs. pressure for penetration was 16.3 in test 1 compared with 8.1% for the later seeded test 2 (Table 1). The toughest variety in test 1 was US H9A with 41% of the plants measuring over 28 lbs. pressure for probe penetration. The most important result to be gained from selection for softer (less fibrous) roots could be the reduction of the proportion of "extra tough" roots, particularly in "tough beet years."

No specific measurements of environmental effects were made in 1978, however, observations of climatic and soil influences were possible between tests 1, 2 and 3. The higher mean toughness of roots in test 2 compared to that of test 1 probably occurred as a result of soil and climate conditions that existed during and for several weeks following seeding. Test 2 was included in test seedings made during a brief interruption in a rainy period. The seedings were made January 31 - February 1 in soil still too wet from rain, followed by several weeks of intermittent rain which kept the soil completely saturated. The result was that, throughout the growing season, test 2 and its companion tests never grew as well or appeared to be as thrifty as either test 1 seeded earlier or test 3 seeded later. Test 1 and test 3 were seeded under conditions nearly optimum for our area.

Field evaluation of environment vs. root toughness will require additional testing to evaluate year and seasonal variation.

Table 1: Sugarbeet root toughness comparisons for two seeding dates, 1978

Variety	Description	Test 1, Seeded 11/16/77					Test 2, Seeded 2/1/78				
		Roots Probed (28 lbs or less)			Roots 28+ lbs on scale		Roots Probed (28 lbs or less)			Roots 28+ lbs on scale	
			Mean[1]	Std. dev.		28+/ total		Mean[1]	Std. dev.		28+/ total
3-way hybrids		No.	Ft. lbs	s	No.	%	No.	Ft. lbs	s	No.	%
464H8	USH7A	142	22.11	3.30	25	15.1	156	22.49	2.90	8	4.8
U913H8	USH9B	92	22.33	3.31	64	41.0	85	23.15	2.58	11	11.4
464H2	USH6	143	22.43	3.06	17	10.6	158	23.43	2.67	9	5.4
117H8	USH10B	142	22.58	3.11	28	16.5	151	22.62	2.70	14	8.5
O. P. lines											
F70-413	Inc. C413	110	21.57	3.10	39	26.2	139	21.84	2.91	14	9.2
417(Ore)	Inc. 813(Ore)	138	21.66	3.24	23	14.3	158	22.19	2.58	16	9.2
Y640	Inc. Y440	148	21.84	3.46	38	20.4	164	22.73	2.61	15	8.4
468	US75	156	21.87	3.06	18	10.3	141	23.08	2.67	16	10.2
Y639	Inc. Y439	151	21.92	3.21	35	18.8	163	22.97	2.81	9	5.2
464	Inc. F66-64	160	22.31	3.06	20	11.1	146	23.16	2.55	10	6.4
Y641	Inc. Y441	155	22.41	2.73	30	16.2	158	23.49	2.33	18	10.2
F1 hybrids											
4547H1[2]	NB1xNB5 CMS	127	22.48	2.95	15	10.6	138	23.57	2.42	16	10.4
F70-546H3	562HOx546 CMS	148	23.26	3.10	43	22.5	162	23.85	2.69	5	3.0
4554H1	NB1xNB4 CMS	127	23.58	3.01	33	20.6	147	24.43	2.27	16	9.8
Inbred lines											
F74-718	Inc. 7418	112	21.96	3.17	9	7.4	120	21.90	2.86	3	2.4
F66-562	Inc. F61-562	93	21.97	3.08	20	17.7	90	22.91	2.48	8	8.2
1502[2]	NB1	68	22.12	3.16	8	10.5	90	23.38	2.31	3	3.2
F66-562HO	562 CMS	104	22.67	3.52	24	18.8	136	23.21	2.58	8	5.6
F67-563HO	563 CMS	108	23.00	3.15	34	23.9	110	23.19	2.93	15	12.0
1502HO[2]	NB1 CMS	48	23.10	2.72	2	4.0	63	23.81	2.63	4	6.0
4554	NB4	108	23.19	2.94	7	6.1	107	23.92	2.48	7	6.1
F70-546	Inc. F63-546	95	23.33	2.94	17	15.2	76	23.30	2.48	7	8.4
4547[2]	NB5	110	23.41	2.84	6	5.2	109	25.14	2.21	23	17.4
F67-563	Inc. F63-563	88	23.97	2.83	35	28.4	105	22.35	3.03	17	13.9
Mean		119.7	22.54	3.09	24.6	16.3	128	23.17	2.61	11.3	8.1
LSD=		$1.96\sqrt{\frac{2(9.55)}{119.7}}$	0.78				$1.96\sqrt{\frac{2(6.81)}{128}}$	0.64			
C. V. (%)			13.7					11.3			

1/Blade dimension for probing was 1 x 15.75 mm (15.75 sq. mm area) x 2.54 cm long.

2/Severe downy mildew infection distorted results in Test 1.

Table 1: (Continued)

Variety	Frequency Distribution of Root Toughness (Pounds Pressure)													
	Test 1, Seeded 11/16/77						13-22 Classes Total Probed %	Test 2, Seeded 2/1/78						13-22 Classes Total Probed %
	13-16	17-19	20-22	23-25	26-28	28+		13-16	17-19	20-22	23-25	26-28	28+	
3-way hybrids														
464H8	7	23	48	36	27	25	47.0	4	20	55	54	23	8	48.2
U913H8	2	19	29	21	21	64	32.1	-	5	29	39	12	11	35.4
464H2	3	23	50	38	29	17	47.5	-	13	45	59	41	9	34.7
117H8	3	27	36	45	31	28	38.8	-	17	63	45	26	14	48.5
O. P. lines														
F70-413	3	36	43	22	16	39	55.0	2	26	60	33	18	14	57.5
417(Ore)	6	30	46	37	19	23	50.9	1	19	71	50	17	16	52.3
Y640	12	27	47	34	28	38	46.2	3	17	57	65	22	15	43.0
468	3	39	49	43	22	18	52.3	2	11	42	59	27	16	35.0
Y639	3	39	43	40	26	35	45.9	1	19	54	53	36	9	43.0
464	5	29	45	55	26	20	43.9	-	14	43	62	27	10	36.5
Y641	3	20	55	58	19	30	42.2	1	5	47	73	32	18	30.1
F1 hybrids														
4547H1	2	21	41	38	25	15	44.8	1	7	40	57	33	16	31.2
F70-546H3	-	23	33	48	44	43	29.3	1	9	42	58	52	5	31.1
4554H1	2	9	36	41	39	33	29.4	-	2	28	64	53	16	18.4
Inbred lines														
F74-718	4	21	40	29	18	9	53.7	3	23	43	39	12	3	56.1
F66-562	3	17	36	24	13	20	49.6	-	9	28	38	15	8	37.8
1502	3	13	19	23	10	8	46.1	-	6	26	41	17	3	34.4
F66-562HO	6	13	29	32	24	24	37.5	-	14	41	52	29	8	38.2
F67-563HO	1	13	34	34	26	34	33.8	2	11	30	41	26	15	34.4
1502HO	-	6	13	19	10	2	38.0	-	4	14	25	20	4	26.9
4554	1	12	37	32	26	7	42.6	-	5	24	46	32	7	25.4
F70-546	1	10	25	35	24	17	32.1	-	5	23	36	12	7	33.7
4547	-	12	33	30	35	6	38.8	-	2	12	37	58	23	10.6
F67-563	-	7	18	33	30	35	20.5	1	15	39	32	18	17	45.1
	3.0	20.4	36.9	35.3	24.5	24.6	41.6	0.9	39.8	48.3	27.4	11.3	11.3	37.0

Table 2: Sugarbeet root toughness comparisons of pollinators and 3-way hybrids, 1978

Variety	Description	Type line or hybrid	Test 3, Seeded 5/2/78 Roots Probed (28 lbs or less) No.	Mean[1/] ft/lbs	Std. dev. s	Roots 28+ lbs on scale No.	28+/ Total %
468	US75	OP	377	19.22	2.72	1	0.3
364	Inc. F66-64	OP	383	19.30	2.58	2	0.5
617	Inc. 417 Ore	OP	363	18.14	3.05	1	0.3
617H8	USH10B	3-way	415	18.44	2.94	3	0.7
F77-36	Inc. C36	OP	375	19.04	3.09	20	5.1
E36H8	546H3 x C36	3-way	409	18.96	3.23	8	1.9
Y601	Inc. Y401A	OP	372	18.58	2.68	7	1.8
Y601H8	546H3 x Y401A	3-way	421	19.14	2.80	7	1.6
Y731	Inc. Y631E	OP	393	18.90	2.98	4	1.0
Y731H8	546H3 x Y631E	3-way	429	19.15	2.75	2	0.5
Y740	Inc. Y640	OP	398	18.06	2.64	4	1.0
Y740H8	546H3 x Y640	3-way	407	18.65	2.97	5	1.2
Mean			395.2	18.80	2.87	5.3	1.3
LSD .05				0.40			
C. V. (%)				15.3			

Table 2: (Continued)

Variety	Frequency Distribution of Root Toughness Pounds Pressure 11-13	14-16	17-19	20-22	23-25	26-28	28+	11-19 Classes Total No. Probed %
468	1	54	171	108	36	7	1	59.8
364	1	44	177	120	30	11	2	57.7
617	10	114	132	79	17	11	1	70.3
617H8	7	94	193	77	34	10	3	70.3
F77-36	2	70	156	96	37	14	20	57.7
E36H8	9	89	149	106	36	20	8	59.2
Y601	5	78	174	78	31	6	7	67.8
Y601H8	-	64	198	108	39	12	7	61.2
Y731	5	73	166	100	36	13	4	61.5
Y731H8	2	66	195	116	40	10	2	61.0
Y740	5	112	179	78	19	5	4	73.6
Y740H8	9	82	183	89	32	12	5	66.5
Mean	4.7	78.3	172.8	96.2	32.2	10.9	5.3	63.9

1/Blade dimension for probing was 1 mm x 1 cm (10 sq. mm) x 2.5 cm long.

SUGARBEET RESEARCH

1978 Report

Section B

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CONTENTS

I. EXPERIMENTAL FIELD TRIALS

A. Agronomic Data

Soil Types: North Farm - silty loam
Farmington Farm - sandy loam

Fertilizer: 950 lbs/acre of 16-20-0

Planting Dates: North Farm - May 12
Farmington Farm - May 5

Thinning Dates: North Farm - June 20 - 23
Farmington Farm - June 12 - 15

Irrigations: Sprinkler irrigated at both farms until two weeks prior to harvest.

Harvest Dates: North Farm - October 10 - 12
Farmington Farm - October 18 - 19

Harvesting Procedures: Tops were removed by beating twice with a roto-beater then topped and dug with a two-row harvester. Beets/plot were counted as they went into a weighing basket on the harvester. Two 10-beet samples were taken at random from each 2-row plot for sugar analysis. All beets in each plot were weighed to determine root yield.

COMMERCIAL AND EXPERIMENTAL VARIETY TEST

J. C. Theurer and D. L. Doney

Nine of the current major commercial hybrid varieties developed in the United States and several experimental varieties were grown at Logan and Farmington, Utah, in 1978. Each entry was planted in six replicates of 2-row plots, 36 feet long with plants thinned approximately 1 foot apart in the row. The Farmington plots had excellent stand--a small amount of curly top and some powdery mildew. The test at Logan had fairly poor stands and severe curly top infection. The Nortron treatment for weed control had a detrimental effect and was probably the major problem in stand reduction at Logan. Sugar percentage, root weight, and quality factors for these varieties are listed in tables 1 and 2.

GWD2 had significantly the greatest yield at Farmington, and UI8 was highest in yield at Logan. An experimental variety, d148, was not significantly different in yield compared to GWD2 at Farmington, but this variety was extremely high in potassium and had the greatest impurity index in the test at this location.

The experimental variety, 46F3 having L19 parentage, and variety ACH14 had the highest sucrose percentage in the test. Stand differences at Logan and the degree of curly top susceptibility greatly influenced the yield of experimental varieties that lacked resistance to curly top.

Table 1. Root yield, sugar percentage, and quality factors for commercial and experimental hybrids at Farmington, UT. 1978.

Variety	Gr. Sugar Lbs/Ac	Rt. Wt. Ton/Ac	% Sugar	N	Na	K	Index
GWD2	9526	28.05	16.9	392	52	1807	511
d148	8396	25.71	16.3	413	173	2275	639
UI8	8005	24.84	16.1	237	152	1492	412
HH22	7795	25.41	15.3	300	151	1879	538
AH10	7737	23.93	16.2	263	133	1618	444
AH12	7693	23.55	16.3	248	109	1389	389
USH10	7427	24.54	15.1	245	171	1903	518
C27	7245	22.05	16.4	343	144	1860	523
UI51	7201	22.89	15.7	251	190	1494	439
UI50	7025	22.59	15.5	223	192	1517	432
USH20	6924	22.17	15.6	254	181	1437	433
46F3	6880	18.98	18.1	311	123	1539	407
g1 O.P.	6500	21.87	14.9	276	152	1813	528
Beta 1345	6373	18.88	16.8	243	94	1542	394
6F5	6345	19.48	16.3	319	112	1692	481
US22/3	6342	20.27	15.6	222	184	1715	459
ACH14	6178	17.77	17.4	243	95	1619	392
39F60	5920	18.29	16.2	326	185	1800	519
41DCO	5825	17.85	16.3	317	109	1813	495
41F23	5822	17.89	16.3	364	121	1691	511
6F4	5440	16.04	16.9	281	145	1422	406
F	10.19	14.84	9.74	3.85	4.94	8.32	6.18
LSD	865	2.33	0.68	78.00	47.00	203.1	71.6
CV	10.95	9.54	3.71	23.8	29.3	10.67	13.46
Mean	6981	21.57	16.21	290	142	1682	471

Table 2. Root yield, sugar percentage, and quality factors for commercial and experimental hybrids at Logan, UT. 1978.

Variety	Gr. Sugar Lbs/Ac	Rt. Wt. Ton/Ac	% Sugar	N	Na	K	Index
UI8	6943	21.85	15.9	430	185	1485	545
AH12	6875	21.79	15.8	494	206	1457	591
USH10	6361	21.31	14.9	465	214	1898	682
GWD2	6089	19.65	15.4	511	146	1538	631
UI51	6007	20.00	15.0	547	336	1535	701
HH22	5792	19.39	15.0	443	201	1734	635
AH10	5699	19.12	14.9	506	234	1726	684
46F3	5626	16.95	16.6	504	158	1397	549
g1 O.P.	5355	18.10	14.8	534	295	1626	710
Beta 1345	5324	16.81	15.8	492	203	1488	592
C27	5216	18.02	14.5	623	306	1600	781
ACH14	5073	15.98	15.9	524	196	1282	575
USH20	5070	17.27	14.7	601	293	1512	739
d148	5067	17.83	14.2	664	299	1729	853
US22/3	5034	16.20	15.5	517	274	1637	661
UI50	4894	16.01	15.3	473	277	1412	609
6F5	4612	14.83	15.5	523	199	1467	618
41F20	4525	15.26	14.8	538	235	1448	663
6F4	4485	13.92	16.1	470	172	1182	514
41F22	3982	13.60	14.6	658	270	1500	774
39F60	3972	12.99	15.2	582	291	1531	701
41F23	3928	13.33	14.7	586	216	1445	698
41DCO	3667	12.10	15.1	598	244	1440	690
41F21	3004	10.42	14.3	694	256	1637	831
F	9.18	9.55	10.02	5.64	7.69	5.72	8.66
LSD	905	2.78	0.53	85.0	51.5	177.9	82.7
CV	15.66	14.65	3.10	13.56	19.1	10.28	10.94
Mean	5108	16.78	15.18	541	238	1530	668

II. SELECTION METHODS

D. L. Doney and J. C. Theurer

Sugarbeets are very sensitive to environmental influences and interact with the varying environmental factors. High interactions are especially noted for root yield and environment (genotype x environment).

In space-planted nurseries (to eliminate competition effect), the majority of the variation in root size is due to environmental effects. Selection in these nurseries generally result in environmental deviates and not genetic deviates. Some exceptions to this are when a severe selection pressure is exerted on the plant population such as disease or insects. However, selection for yield on an individual plant basis has not been successful because of the large environmental interactions.

Progeny testing has been a more reliable method for selection for root yield. However, this requires a large outlay in land, time, equipment, and labor.

Over the past several years, we have been investigating alternate methods of selection in an attempt to develop a more reliable, more precise, and more efficient selection procedure. In this section, we will report on several of these selection methods.

HYPOCOTYL DIAMETER AND SPECIFIC GRAVITY

Devon L. Doney

In the past, we have reported on the hypocotyl diameter and specific gravity techniques separately. The hypocotyl diameter (HD) technique was developed for root yield without any regard to percent sugar, whereas the specific gravity (SG) is a test for percent sugar without any regard to root yield.

These two selection methods tend to have inverse relationship; i.e., selection for large HD gives an increase in root yield and a decrease in percent sugar, while selection for SG gives an increase in percent sugar and a decrease in root yield.

In this experiment, we selected for both parameters in the same population. For specific gravity, we divided the population into three groups - SG1 (high SG), SG2 (medium SG), and GS3 (low SG). Likewise the population was divided into three groups for HD (high, medium, and low). Selected plants were allowed to interpollinate in their respective groups and seed harvested for groups: SG1, SG2, SG3, high HD, medium HD, and low HD. Plants with both SG1 and high HD were few in number and produced insufficient seed for testing.

These six selection populations were tested in the field along with the original parent population and check varieties; GWD2, UI8, AH10, and US22/3 (Table 1). The results tend to confirm our earlier findings. The SG3 population (h534) gave the lowest percent sugar, and the low HD population (h545) gave the highest percent sugar (Table 1). The root yield for the HD selections was high > medium > low. One deviation that was not expected was the SG1 population, (h532), which gave a medium percent sugar and a high root yield. We expected a high percent sugar and low yield. Its yield and gross

sugar were significantly greater than the commercial check hybrids. This selection needs further testing to verify its superior performance. The parent (f354) was close to the test mean for all measured characters.

Table 1. Percent sugar, root yield, gross sugar, and impurities for parent - Selections for HD, selections for SG, and check hybrids.

Code	Description	% Sugar	Ton/AC	Lbs/AC	N	Na	K	Index	Rt. No.
h532	SGI of f354	15.2	23.24	7013	531	354	1695	715	68.2
h544	High HD of f354	15.6	21.85	6834	500	234	1454	607	62.7
GWD2	GWD2	15.6	19.35	6210	558	166	1379	620	69.5
UI8	UI8	15.5	19.89	6175	502	249	1280	588	69.0
AH10	AH10	15.2	20.11	6174	542	219	1572	668	54.3
f354	Parent	15.6	19.53	6103	478	285	1458	606	62.3
h542	Med. HD of f354	15.4	19.79	6084	391	289	1423	551	59.5
h533	SG2 of f354	15.4	19.18	5893	605	321	1652	734	57.7
h545	Low HD of f354	16.0	18.34	5861	375	245	1458	518	58.8
h534	SG3 of f354	14.9	19.57	5795	530	409	1523	710	53.8
F		2.62	2.76	2.67	5.00	13.37	4.08	8.35	2.15
LSD		0.51	2.98	936.7	83.4	48.5	163.3	65.8	10.8
CV		2.9	13.3	13.6	14.60	15.51	9.64	9.10	15.77
Mean		15.4	19.4	5964	510.8	276.2	1496.6	639.3	60.61

This test points out the need to combine both of these selection methods into a selection index. Since it is easier to test for SG than HD, a practical approach would be to discard all beets below a set SG and test only those beets above the set GS for HD. This can be easily accomplished by 1) preparing a tank or barrel of salt (NaCL) solution of the desired SG, 2) dumping all beet roots into the solution, and 3) saving only those that sink. The saved roots can then be tested for HD by our published method. This system would allow the breeder to select in large populations with a minimum amount of time and effort.

SEEDLING SELECTION

D. L. Doney

Over the past few years, we have investigated several seedling selection methods. One method that has proven successful is the hypocotyl diameter of 3-week-old seedlings.

The hypocotyl diameter selection technique has been tested over a wide range of genotypes and in several breeding methods. In most cases, it has proven successful in improving root yield but results in a decrease in sugar percentage. This past year we have been investigating methods of including selection for sugar percentage in the seedling stage in connection with the hypocotyl diameter selection.

Since our studies of osmotic potential in the seedling stage indicated that this criterion would be effective only on L19 type germplasm, we have take an alternate selection approach and developed the following hypothesis:

Facts:

(1) Plants largest in diameter at 3-weeks grow most rapidly and are largest in root yield at harvest time.

(2) Small celled plants have the highest sugar percentage.

(3) Small celled plants have highest percent dry weight because of more cell wall per unit volume.

Therefore:

(1) Percent dry weight in the seedling stage will give a relative measure of sugar percentage potential and

(2) Total dry matter per unit time will give a relative measure of total sugar production potential.

We have adapted an agar cutter for cutting 3mm sections from the hypocotyl of 3-week-old seedlings. Measurements made on these 3mm sections are diameter, percent dry weight, and total dry weight. From these data, the following assumptions are made:

Root diameter	=	root yield potential
% dry weight	=	% sugar potential
Total dry weight	=	total sugar potential

From a test involving 20 hybrids varying in yield and percent sugar, significant correlations of 0.65, 0.69, and 0.60 were obtained for the above relationships, respectively.

In another test, 13 hybrids were divided, using the above relationships, into high, medium, and low for percent sugar, root yield, and total sugar (Table 5).

Table 5. Classification of hybrids into high, medium, and low classes for % sugar, root yield, and gross sugar based on the percent dry matter, root diameter, and total dry matter of 3mm root sections of 3-week-old seedlings.

% Sugar		
High	Medium	Low
L19	AH12	Beta 1345
ACH-14	Mono-Hy-E4	GWD2
L53xL19	UI-HS-Hybrid	Hilleshog Broadbase "Z"
Mono-Hy-Z1	Hilleshog Vytomo	(EL30x030)xL10
	L9xL19	

Root Yield		
High	Medium	Low
AH12	(EL30x030)xL10	ACH-14
GWD2	Beta 1345	L19
Mono-Hy-Z1	UI-HS-Hybrid	L53xL19
L9xL19	Hilleshog Vytomo	Mono-Hy-E4
	Hilleshog Broadbase "Z"	

Gross Sugar		
High	Medium	Low
GWD2	ACH-14	Mono-Hy-E4
AH12	Beta 1345	Hilleshog Broadbase "Z"
L9xL19	L53xL19	(EL30x030)xL10
Mono-Hy-Z1	Hilleshog Vytomo	L19
	UI-HS-Hybrid	

These criteria placed most of the hybrids in the right class (high, medium, or low); however, some hybrids were misclassified. This classification may be improved with better control of environmental variation.

We have made selections in a heterozygous population for different combinations of the above relationships. These selections will go through a generation for seed increase and tested in the field for effects of the different types of selection pressure.

RECIPROCAL RECURRENT SELECTION

D. L. Doney and J. C. Theurer

The reciprocal recurrent selection breeding method (RRS) has been adapted to sugarbeet and published in Field Crops Research 1 (1978) 173-181 (a new international journal published by the Elsevier Scientific Publishing Company, Amsterdam, The Netherlands).

This past year was the fourth year of the first cycle of RRS. Seed produced from crossing blocks of the two populations in 1977 was tested in replicated field trials. Of the 33 lines in Population A, 21 produced sufficient seed for field testing. However, only 11 of the 33 lines in Population B produced enough seed to test in replicated field trials. It should be noted that the seed produced in Population A resulted from each Population A line crossed to a random sample of all lines in Population B and vice versa for seed produced in Population B. Therefore, these trials were to test the combining ability of lines in Population A with Population B and lines in Population B with Population A.

Table 2. Percent sugar, root yield, gross sugar and impurity factors for combining ability of lines in Population A to Population B.

Code	No.	% Sugar	Rt. Wt. Ton/AC	G.R. Sugar Lbs/Ac	N ppm	Na ppm	K ppm	Index	Root Number
25F18	1512	15.4	20.35	6285	571	323	1548	733	50.7
GWD2	1523	14.9	20.72	6178	501	214	1425	625	64.0
25F4	1503	15.6	19.09	5948	495	328	1473	628	56.8
25F9	1506	15.5	18.58	5753	485	283	1591	632	51.0
25F7	1505	15.3	18.18	5590	525	287	1551	662	57.5
25F35	1521	15.6	17.78	5518	572	155	1672	670	43.5
25F1	1501	15.2	17.97	5464	512	342	1611	681	56.5
25F10	1507	15.6	17.11	5361	418	202	1243	514	54.8
25F15	1510	15.4	16.92	5210	585	265	1530	689	45.3
25F23	1516	15.0	17.19	5185	443	376	1445	624	54.5
US22/3	1522	15.4	16.78	5140	493	323	1536	648	50.7
25F28	1518	15.2	16.76	5117	489	196	1303	579	59.2
25F13	1508	16.0	15.98	5095	506	305	1636	640	48.3
25F14	1509	15.0	16.60	4992	474	319	1484	642	50.0
25F32	1519	15.6	15.58	4840	487	248	1327	583	46.3
AH12	1524	15.3	15.45	4733	535	263	1223	609	50.0
25F34	1520	15.7	14.65	4601	513	267	1435	614	49.0
25F17	1511	15.1	15.15	4584	508	342	1575	677	39.7
25F27	1517	15.7	13.76	4322	459	340	1357	584	36.8
25F19	1513	14.7	14.30	4216	550	284	1444	689	46.2
UI50	1525	14.8	14.16	4205	488	408	1308	649	41.8
25F2	1502	15.8	13.23	4182	569	237	1422	638	36.7
25F20	1514	15.9	13.04	4150	480	226	1565	598	42.8
25F21	1515	15.9	12.69	4026	471	213	1483	578	30.2
25F6	1504	15.3	11.49	3532	606	318	1610	732	24.3
F		2.74	4.06	3.57	2.20	5.62	2.78	3.33	4.05
LSD		0.58	3.27	1045	85.3	71.6	206.4	76.0	12.6
CV		3.35	17.91	18.59	14.78	22.37	12.39	10.55	23.60
Mean		15.40	16.14	4969	509.9	283.1	1472	637.2	47.47

Table 3. Percent sugar, root yield, gross sugar, and impurity factors for combining ability of lines in Population B to Population A.

Code	No.	% Sugar	Rt. Wt. Ton/AC	G.R. Sugar Lbs/Ac	N ppm	Na ppm	K ppm	Index	Root Number
25F46	1607	15.8	21.55	6816	470	208	1415	569	55.7
GWD2	1613	15.6	21.18	6574	524	178	1467	614	70.3
25F45	1606	15.4	19.76	6099	564	320	1581	697	51.7
25F38	1601	16.1	18.90	6070	544	171	1442	601	61.3
AH12	1614	15.6	19.28	5997	501	236	1311	587	58.7
25F62	1609	15.7	18.82	5928	413	333	1613	594	57.8
25F41	1603	15.5	18.13	5617	545	212	1318	631	52.7
US22/3	1612	15.7	17.81	5580	492	302	1452	615	58.3
25F39	1602	15.3	17.86	5480	456	322	1310	585	53.3
25F52	1608	15.7	17.38	5476	496	279	1275	579	58.3
UI50	1615	14.7	18.02	5286	456	312	1303	608	54.2
25F42	1604	15.7	16.73	5264	578	181	1410	635	45.2
25F63	1610	15.9	16.25	5207	556	181	1535	629	42.3
25F44	1605	15.3	16.44	5038	562	322	1451	678	53.8
25F69	1611	15.4	14.32	4419	462	304	1480	644	39.5
F		2.54	2.56	2.54	2.57	6.33	3.32	1.75	3.08
LSD		0.58	3.26	1062	86.0	69.6	159.2	74.8	12.2
CV		3.28	15.84	16.59	14.95	23.86	9.88	10.73	19.8
Mean		15.56	18.16	5657	508.4	257.9	1425	616.99	54.2

The results of these field trials are given in Table 2 for Population A and Table 3 for Population B. Significant differences between lines (differences in combining ability) were noted for all measured characters (tables 2 and 3). In both populations, there were lines equal to or better than the commercial hybrids in percent sugar, root yield, and gross sugar. It appears that there are sufficient superior genes in this material to make progress in subsequent selection cycles.

Although there was insufficient seed to test all lines in replicated field trials, there was sufficient seed to test all lines in the hypocotyl diameter test in the greenhouse. All lines were tested for hypocotyl diameter at three weeks of age. In addition, a 3mm section was taken from each root, and the total and percent dry matter were determined. This method will be discussed in more detail in the following section.

These data for both population lines are presented in Table 4 as deviations from the mean. From these data, lines were selected for high HD, high total DM, high percent DM, and combinations of these parameters.

The selection cycle schedule was to plant stecklings of the selfed seed of the selected lines for a polycross next year. However, due to a misunderstanding, the seed was not planted. This will set our program back a year; i.e., selfed seed of the selections will be planted in 1979 and the "polycross of best lines" completed in 1980.

Table 4. Deviations from the mean for hypocotyl diameter, total dry weight, and percent dry weight of populations A and B. Determinations were made on 3-week-old seedlings.

	Population A				Population B		
		Total				Total	
Code	HD	DW	%DW	Code	HD	DW	%DW
25F1	+ 2.2	- 3	- 9	25F38	+ 4.5	+27	+ 3
25F2	+ 1.2	+15	+16	25F39	- 3.8	-28	-13
25F4	-13.6	-63	-11	25F40	- 6.3	-25	+ 3
25F5	+10.4	+24	- 6	25F41	+ 4.8	- 2	-20
25F6	+ 8.1	+16	-10	25F42	- 1.3	- 7	- 2
25F7	-12.1	-28	+18	25F43	-10.1	-51	+ 1
25F8	- 0.3	-21	-17	25F44	- 2.1	- 9	-18
25F9	+ 2.4	+10	+ 6	25F45	+10.2	+45	- 6
25F10	- 4.1	-33	-17	25F46	- 4.1	-40	-22
25F11	- 7.0	-13	+16	25F48	+ 5.8	+73	+31
25F12	+15.7	+57	+ 3	25F51	+ 0.1	+33	+29
25F13	+17.3	+46	-14	25F52	- 0.5	- 2	+ 5
25F14	0.0	+16	+18	25F53	+ 5.3	+72	+56
25F15	+10.4	+41	+ 5	25F54	+ 4.0	+13	+ 1
25F16	+ 7.2	+60	+41	25F55	+ 9.6	+49	- 4
25F17	+ 6.7	+12	-11	25F56	+ 9.1	-13	-49
25F18	-16.6	-88	-14	25F57	- 9.6	-19	+28
25F19	+10.2	+32	-14	25F58	+ 0.6	-22	-16
25F20	+11.5	+42	+ 4	25F59	+ 2.0	- 4	- 9
25F21	+ 3.1	+25	+15	25F60	- 2.4	-17	- 2
25F22	+ 7.4	+16	- 9	25F61	+ 8.4	+22	-17
25F23	- 9.2	-43	- 8	25F62a	+ 1.1	-20	-21
25F24	-15.7	-44	+13	25F62b	+ 2.3	+ 8	- 3
25F27	-13.7	-34	+17	25F63	+10.4	-13	-15
25F28	- 5.1	-33	-13	25F64	+ 4.1	+ 4	-12
25F29	- 0.2	-11	-13	25F65	- 2.6	+33	+42
25F30	+ 3.3	- 9	-18	25F67	- 4.0	-46	-24
25F31	+ 0.7	-12	-10	25F68	-20.0	0	0
25F32	+ 5.3	+31	+ 4	25F69	- 9.6	-49	- 1
25F33	- 0.8	+ 6	+ 5	25F70	+ 6.2	+40	+ 5
25F34	+ 4.7	+24	+ 5	25F71	- 4.8	-29	+ 1
25F35	- 8.0	-14	+27	25F72	+ 8.0	+ 8	-21
25F36	- 5.4	-19	0	25F73	- 8.5	-18	+26

COMPARISON OF HIGH AND LOW HYPOCOTYL DIAMETER AND ROOT/LEAF RATIO SELECTIONS

J. C. Theurer and D. L. Doney

Two seedling selection methods have been suggested for rapid and efficient improvement of sugarbeet yield. One method is based on the measurement of the hypocotyl diameter of seedlings grown in sand benches in the greenhouse for 21 days (1). Selection by a second method is based on the ratio of tap root fresh weight:leaf blade (laminae) fresh weight for 21-day-old seedlings grown in a growth chamber (2), hereafter called R/L ratio method.

In 1977, high and low hypocotyl diameter selections were made from the heterogeneous population 6F3 in accord with the standard published (1) technique. After photothermal induction of selected seedlings, they were grouped by high and low plants in greenhouse isolators for seed increase. Selection was made for R/L ratio in the same population by a modification of the technique suggested by Snyder and Carlson (2). Plants were seeded in 6-inch pots in a sand bench in the greenhouse. The day after emergence they were thinned to a single plant per pot, and thereafter each pot was irrigated daily with an equal volume of complete nutrient solution. Plants were continually illuminated with a bank of gro-lux lights 24 inches above the bench. The plants were rotated to a different site in the sand bench every four days to more uniformly control environmental influences. Plants were harvested after 35 days growth which was about the same stage of plant development that Snyder used when selection was made in a growth chamber (personal communication). Tap root fresh weight and laminae weight were obtained on each plant. The highest 10% R/L ratio plants and the lowest 10% R/L ratio plants were selected for seed increase in isolation units.

In 1978, a field comparison was made of the four mass selections and the parent population. Because seed was limited for the selections, they were first seeded into Japanese paper pots, then transplanted to the field. Each field plot consisted of two rows 36 feet long with plants 1 foot apart in the row. Six replicates of the five entries were studied. Non-competitive beets were eliminated from the plot at harvest, then the root weight, top weight, and sucrose percentage were determined.

RESULTS

Early in the growing season, mid-June, the high R/L ratio plants showed greater vigor and more top growth than the other selections, or parent population. By the latter part of August, this difference in top growth was no longer apparent. The Low Hypocotyl Diameter Selection showed considerable variability in top growth of individual plants at harvest. This variability also has been noted for Low H.D. selections in other populations. The top growth of other entries was relatively uniform.

The root weight, top weight, and sucrose percentage for the selections and parent are shown in Table 1. The High R/L Ratio, Low R/L Ratio, and High H.D. selections had a greater mean weight per beet than the parent. Low H.D. had lower root weight than the parent. However, none of the root weights differences were significant. The Low HD Selection had significantly more top

Table 1. Comparative root weight, top weight, sucrose percentage and gross sugar for seedling selection methods.

Selection	Gross Sugar T/AC	Root Weight g/Beet)	Top Weight g/Beet	% Sucrose
High R/L Ratio	25.2	961	841	15.3
Low " "	25.1	957	832	14.6
High H.D.	24.9	952	828	14.9
Low "	22.0	839	1008	14.8
Parent	23.9	926	863	14.4
Mean	24.2	927	874	14.8
LSD 0.05	3.1	50	77	0.8
C.V.	4.94	4.60	7.46	4.30

weight than the parent and the three other selections. The High R/L Ratio Selection had significantly higher sucrose percentage than the parent population. This may have been a chance occurrence, however, since selection for Low R/L Ratio was ineffective.

Evaluations of H.D. and L/R Ratio Selection will be continued for the next few years, using both mass and recurrent selection methods.

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1. Doney, D. L. and J. C. Theurer. 1976. Hypocotyl diameter as a predictive selection criteria in sugarbeet. Crop Sci. 16:513-515.

2. Snyder, F. W. and G. E. Carlson. 1978. Photosynthate partitioning in sugarbeet. Crop Sci. 18:657-661.

III. PHYSIOLOGICAL GENETICS

SEEDLING PHYSIOLOGY

D. L. Doney

There has been much discussion and research in recent years concerning the development of physiological selection criteria (selection based on principle metabolic functions). A critical fundamental necessary for the development of physiological selection criteria is a knowledge of the basic physiology. In particular, if we are going to be able to develop effective selection criteria in the seedling stage, we must know the basic development, growth parameters, and physiology of the sugarbeet seedling. In this section I will report a summary of our seedling physiology studies.

1. Germination - The first plant part emerging from the seed is the radical. It is generally 2-3cm in length and is made up of 8 to 10 rows of cortex cells with a center core of meristematic tissue (very small cells). The number of cortex cells is relatively consistant with only a slight variation in number between widely divergent genotypes. However, there is a large difference in cell size between genotypes. The cell size of cortex cells correlates with the genetic cell size potential of a particular genotype. These cells do not divide but increase in size as the center meristematic cells divide and grow. These cells grow and stretch and are eventually sloughed off when the plant is about 3 weeks old. The splitting of the root at this stage is the sloughing off of these cells.

2. True Root - The true root develops from the growing center core. A primary cambium is first initiated when the plant is about 10 to 15 days old. The remaining cambial regions (rings) are developed very rapidly from this primary cambium outward. By the time the plant is 30 to 35 days old (root 2-3cm in diameter), all the cambium rings are complete. Vascular bundles (xylem and phloem) are formed around the cambial layers. Storage parenchyma cells separate the cambial layers. By the time the root is 2-3cm in diameter, root differentiation is complete. From then on, growth is by cell enlargement and cell division taking place at the same time. The hypocotyl (root portion above soil level) becomes indistinguishable from the tap root as the root matures. The cambial rings are difficult to follow in the crown where the vascular bundles tend to converge to the vascular bundles coming from the petioles.

3. Leaves - The emerging cotyledons carry on photosynthesis until about the four-to-six-leaf stage when they senesce and drop off. The first true leaves emerge at about 10 to 15 days after germination. Leaves emerge in pairs and are initiated at about two to four per week throughout the growing season. In the early stages of growth, the leaves grow more rapidly than the root, but, as the root becomes more dominate, it demands more photosynthate and grows more rapidly.

4. Growth Curves - Seedling growth will be illustrated by growth curves of three divergent genotypes: 1) Blanca (high yield, low sugar); 2) GWD2 (high yield, medium sugar); 3) L19 (low yield, high sugar). The fresh weight curves for top and root are shown in figures 1 and 2. The rate of growth is very slow until the plants are about 15 to 20 days old.

After this point, the rate of growth for both tops and roots increases very rapidly. This increase corresponds with the development of the first true leaves. Differences between genotypes were evident at a very young age. The rate of increase in root-fresh weight is faster than that for leaves after about 25 days. This is reflected in the change in root/shoot ratio (Figure 8). The dry weight growth curves were similar to the fresh weight curves (figures 3 and 4), except the genotype L19 began increasing in dry weight (faster than Blanca), in both the root and top at about 30 days. This change reflects the higher percent dry weight of the L19 genotype (figures 5 and 6). Percent dry weight increased with time for all three genotypes in both roots and tops (figures 5 and 6). Significant differences between genotypes could be detected for percent dry weight as early as 15 days of age. Differences in root diameter were also detectable at a very young age (Figure 7). An important fact about most of the growth curves is that the genetic differences are established very early and those relative differences remain throughout the remainder of the growing season.

Another important curve is the root/shoot ratio (Figure 8). The ratio decreases up to about 25 days of age. This is because the leaves are growing more rapidly than the roots. At between 20 and 30 days of age, the ratio changes and begins increasing. This happens for all genotypes and is graphed for such divergent genotypes as GWD2 and L19 (Figure 8). The change in this curve reflects the shift in root growth. Although the root is still much smaller than the top, it is growing at a faster rate. This continues throughout the growing season, and the root eventually exceeds the top weight. The point of inflection (change in direction) of this curve corresponds to the stage of root differentiation at which time all cambial rings are formed. At this point more meristematic tissue is available in the root to demand photosynthate. The plant responds by sending a higher portion of the available photosynthate to the root. It is at this stage that the sink strength of the root becomes dominant rather than later on when the root exceeds the top in weight. This suggests that the shift in photosynthate partitioning is due to photosynthate demand rather than hormonal.

The relative relationship of this ratio between genotypes is established at a very early age, although the curve changes in direction with time. This relationship is evident throughout the growing season as shown in Table 1. Two genotypes (L19 and L10), differing greatly for root/shoot ratio, had the same ratio relationship from the first of July to the middle of September (Table 1).

Table 1. Root/shoot ratio for L19 and L10 from July 1 to September 8.

	Rt/Shoot Ratio		L19 as
	L19	L10	% of L10
July 1	.158	.241	66%
July 28	.419	.661	64%
August 18	.692	1.125	62%
September 8	.890	1.364	65%

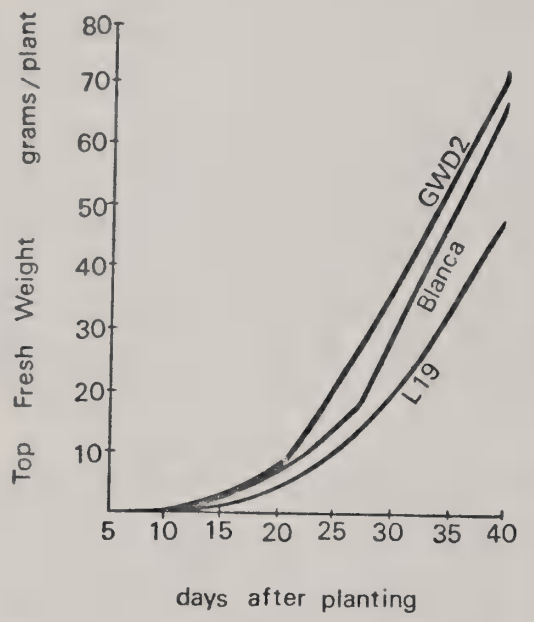

Figure 1. Top fresh weight for GWD2, Blanca, and L19 from 5 to 40 days.

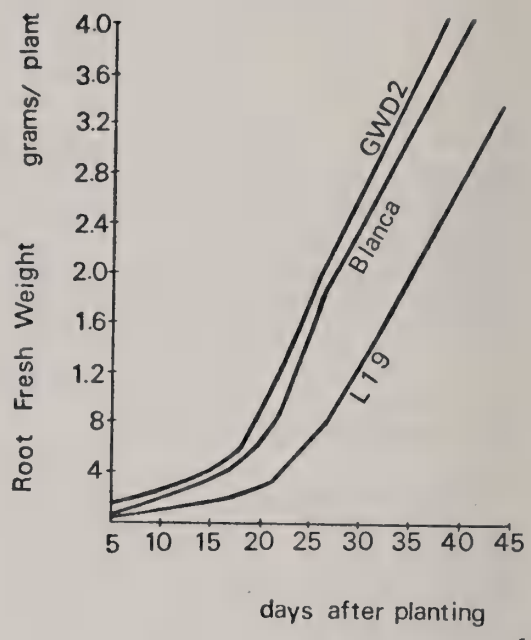

Figure 2. Root fresh weight for GWD2, Blanca, and L19 from 5 to 40 days.

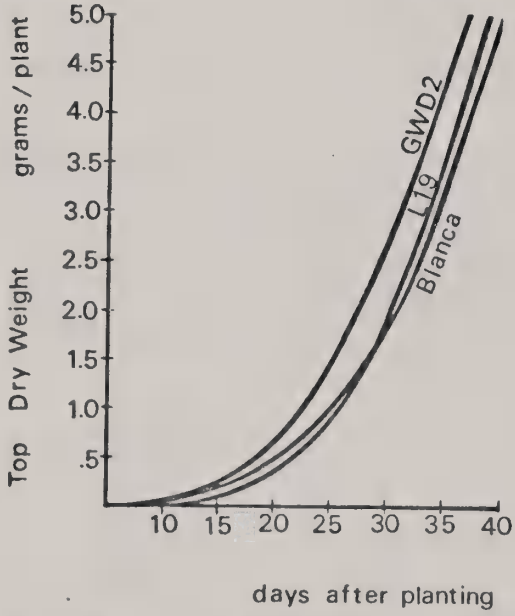

Figure 3. Top dry weight for GWD2, Blanca, and L19 from 5 to 40 days.

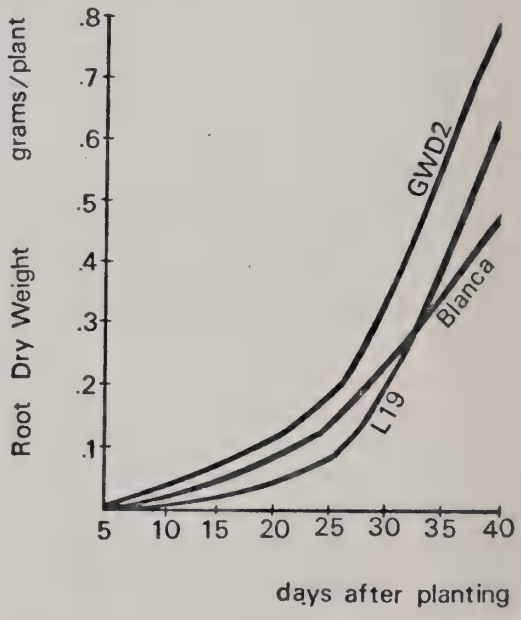

Figure 4. Root dry weight for GWD2, Blanca, and L19 from 5 to 40 days.

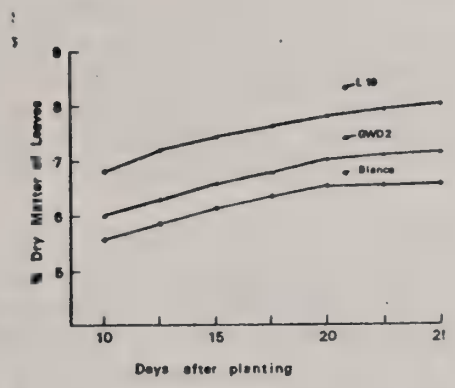

Figure 5. Percent dry weight of leaves for GWD2, Blanca, and L19 from 10 to 25 days.

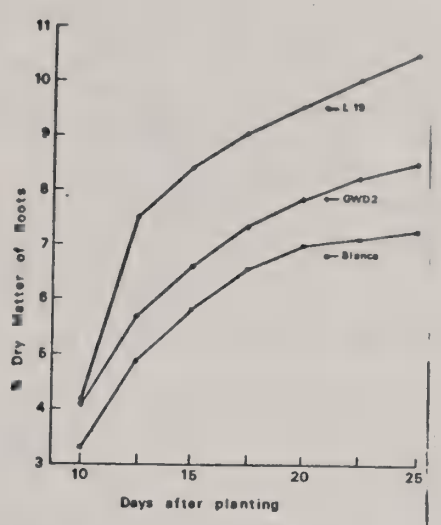

Figure 6. Percent dry weight of roots for GWD2, Blanca, and L19 from 10 to 25 days.

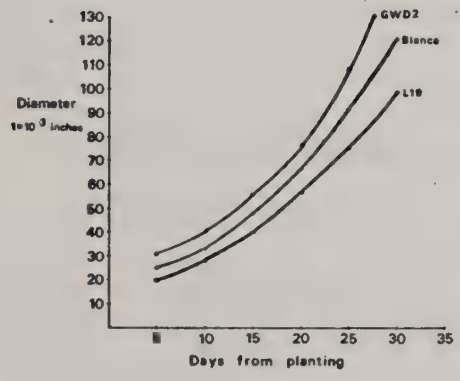

Figure 7. Hypocotyl diameter for GWD2, Blanca, and L19 from 5 to 30 days.

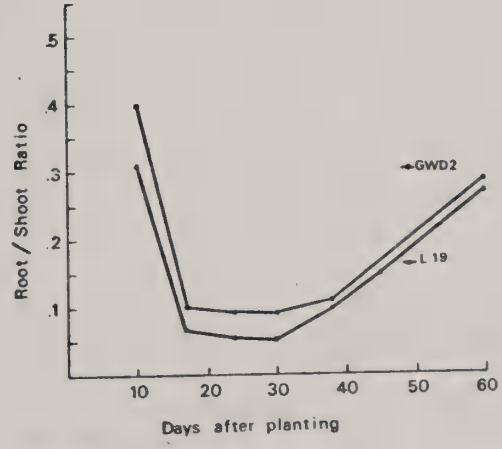

Figure 8. Root/shoot ratio for GWD2 and L19 from 10 to 60 days.

PHYSIOLOGY OF SUGAR PRODUCTION

D. L. Doney

When we select for total sugar production, we are selecting at the endpoint of a number of complex biochemical, physiological, and developmental processes. Each one of these complex processes interacts with each other and with other environmental influences. The effect of these interactions is an increase in variation at the endpoint of selection over any one of the components or combination of component processes. For this reason, selection for genetic differences at the endpoint is very difficult and generally results in differences due to environment rather than genetic.

Many attempts have been made at selecting on less complex processes as an alternate trait. However, much of this effort has been a random testing of procedures rather than a systematic approach and has been unsuccessful. We feel that a systematic approach will be much more productive; i.e., identifying limiting processes at each subsequent lower level of complexity. Sugar production can initially be reduced to root yield and sucrose percentage. In this section, I will report on the next lower level of complexity:

1. Root Growth - After ring differentiation is completed (when the root is about 2-3cm in diameter), root growth is by cell division and cell enlargement taking place at the same time. Genetic differences in root size are determined by genetic differences in cell size and genetic differences in cell division rate. An example is given in Table 2 of these genetic differences and how cell size and cell division rate interact. Blanca is a low sugar mangle, and L19 is a high sugar line. Data are for true root tissue of young plants (15 to 30 days of age); however, genetic differences are already established. At 15 days there is no difference in cell size, but by 30 days the cells of Blanca are twice the size of L19. L19 has less true root cells at 15 days than Blanca; however, it has a faster cell division rate than Blanca, and by 30 days it has almost twice as many cells as Blanca. Thus, the genotype with small cells compensates by producing more cells. This gives them

Table 2. Cell size, cell number, and surface area for Blanca and L19 from 15 to 30 days after planting. Measurements are for true root cells only.

					3mm Section			
Line	Age (days)	Cell Diameter	Cell Size	Surface Area/ Cell	Volume	Total Surface Area	Surface Area per Volume	Cells
		cm	$X10^{-9}$	$X10^{-6}$	cm^3	cm^2	cm^2/cm^3	
Blanca	15	.00107	0.65	3.60	.000106	0.59	5540	163,897
	20	.00120	0.92	4.60	.000401	2.00	4997	435,583
	25	.00132	1.19	5.39	.000951	4.31	4528	798,990
	30	.00141	1.47	6.33	.001846	7.95	4307	1,256,082
L19	15	.00107	0.64	3.60	.000525	0.30	5625	82,032
	20	.00108	0.67	3.66	.000338	1.85	5470	505,155
	25	.00110	0.70	3.80	.000887	4.81	5426	1,266,566
	30	.00112	0.73	3.94	.001715	9.26	5399	2,349,905

almost the same volume at 30 days. A cubic cm of small cells will have more surface area (cell wall) than a cubic cm of large cells. Therefore, the small-celled genotype L19 has more surface area (12%) than the large-celled genotype (Blanca), although it is about 7 percent smaller in volume. More photosynthate is being partitioned per unit volume to cell wall in L19 than in Blanca. Consequently, L19 has a higher percent dry weight than Blanca.

2. Percent Sugar - Last year, we reported on the relationship of osmotic potential and sugar percentage potential. Since only L19 high-sugar germplasm could be detected in the seedling stage by osmotic pressure, we have investigated other parameters influencing sugar percentage.

One parameter that seems to be consistent in all the material we have studied is the relationship of percent sugar to cell size. Small-celled genotypes have high-sugar percentage, and large-celled genotypes have low-sugar percentage. This is consistent with other workers also.

This relationship was also present in our hypocotyl diameter studies. One of the problems with our hypocotyl selection populations was that it was accompanied with a decrease in sugar percentage even though we were able to increase root yield. Cellular level studies of our hypocotyl diameter selections revealed that the selections were larger because the cells were larger (Table 3). In all three tests studied, the selections with large hypocotyl diameter had larger cells (Table 3). Cortex cells (initial cells laid down by the germinating seed) were also larger for the large hypocotyl diameter selections (Table 4). An inverse relationship between sugar percentage and cortex cell size was present in this material (Table 4).

Table 3. Hypocotyl diameter and mean cell size of 3-week-old seedlings for large and small hypocotyl diameter selections.

		Hyp. Dia.	Cell Size $cm^3 \times 10^{-8}$
Test 1	Large HD	107.1	9.4
	Small HD	93.2	6.2
Test 2	Large HD	119.3	7.6
	Small HD	109.2	6.8
Test 3	Large HD	127.4	7.3
	Small HD	111.9	5.5

Table 4. Cortex cell size and sugar percentage of large and small hypocotyl diameter selection.

CORTEX CELLS OF 6-DAY-OLD SEEDLINGS

	Cell Volume cm^3	% Sugar
Large HD Selection	9.4×10^{-8}	14.5
Small HD "	6.2×10^{-8}	15.4

In a study involving Blanca (a low-sugar line) and L19 (a high-sugar line), a direct relationship between sugar percentage and cell wall per unit area was observed. These two genotypes differed 9-fold in mean cell size; i.e., Blanca had cells nine times larger than L19. However, the cell wall (surface area per cubic cm) of L19 was almost twice as great as that for Blanca. The sugar percentages were 9.5 and 18.0 for Blanca and L19, respectively. Thus, the difference between Blanca and L19 in cell wall per unit area was about the same as the difference between these two genotypes in sugar percentage. We have observed this relationship in other genotypes.

3. Yield - % Sugar Relationship - These effects and relationship at the cellular level are diagramed in a simple form in Figure 9. Root yield is influenced by both cell size and cell division rate; whereas, sugar percentage is determined largely by cell size and, to a lesser degree, by osmotic potential. This implies that genes that increase yield by increasing cell size are the same genes that affect sugar percentage. If we increase yield by increasing cell size, we will decrease sugar percentage. However, if we increase yield by increasing cell division rate, we will not affect sugar percentage.

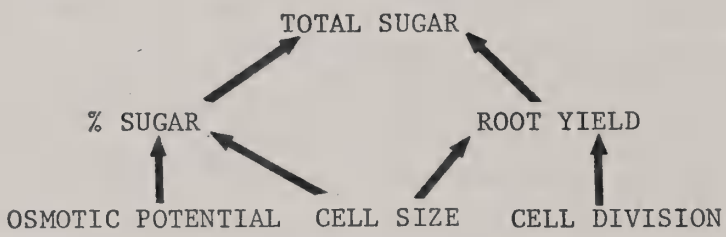

Figure 9. Cellular level components of percent sugar and root yield.

The way these parameters (cell size, cell number, and surface area per unit area) interact with each other is demonstrated in Table 5. These data are presented in relative measurements to demonstrate these relationships but are obtained from actual data. Blanca has a much larger cell than L19 but has a slower cell division rate. When these two factors are multiplied together to obtain a relative size, it corresponds very closely to the relative root yields obtained from actual field trials (Table 5). The relative surface area per

Table 5. Relative cell size, cell division rate, surface area per volume, total surface area, and root yield and gross sugar for Blanca, and L19. Relative cell size and cell division rate were determined from 3-week-old seedlings. Root yield and gross sugar were from a field trial.

	Relative Cell Size Diameter [1]	Relative Rate of Cell Division Diameter	Relative Size Diameter	Root Yield Tons/ha	Relative Surface Area/cm^2	Relative Total Surface Area/cm^2 [2]	Gross Sugar Tons/ha
Blanca	11.34	3.97/day	45.0	45.0	1.00	4.05	4.05
L19	5.43	5.76/day	31.2	29.1	1.95	5.49	5.24

[1] cm^2 x constant

[2] Relative cell size x division rate x surface area/cm^2 ÷ 11.08

unit area for L19 is about twice that for Blanca and corresponds to their relative sugar percentages. When the relative surface area is multiplied by the relative size, a figure is obtained for the relative total surface area (cell wall area) which corresponds to the total gross sugar obtained from field trials (Table 5).

HORMONE EFFECTS AT THE CELLULAR LEVEL

D. L. Doney

Our research over the past few years has brought out the importance of cell and cell division rate in sugar production. Both of these factors can be manipulated, or changed, genetically. However, changing both in the right direction (small cell size and rapid cell division) is difficult genetically because of compensating effects in photosynthate partitioning. In the physiology of the plant, it seems reasonable to assume that hormones are the key compound conditioning these two parameters, both genetically and environmentally. This past year we have been investigating the effects of a number of hormones on cell size and cell division. Of particular interest are those hormones that affect cell division. In this report, I will report on studies with 2,4-D (2-4, Dichlorophenoxyacetic acid), IAA (Indoleacetic acid), Dow Co 290 (3,6-Dichloropicolinic acid), and Kinetin (6-Benzyl-amino purine).

1. 2,4-D - Several tests were conducted with 2,4-D. Treatments were applied as a spray to the leaves at the two-to-four-leaf stage. Plants were harvested and measurements taken two weeks after treatment. Treatments of greater than 1 ppm were harmful to the plants. This corresponds to about one two-hundredths (1/200) of an ounce per acre. At harvest time, root sections were made and stained for cell size measurements.

In a comparison between concentrations of 0.1 ppm to 10 ppm (Table 8), the 10 ppm had a detrimental effect on the plants. This treatment caused an elongation and twisting of the petiole and a proliferation of root hairs. Few usual effects were observed for the 0.1 ppm and 1 ppm treatments. Data (Table 8) indicate the 0.1 ppm treatment had little effect on the measurements taken. The 1 ppm treatment gave a decrease in top yield and an increase in root yield (Table 8). This increase was largely due to an increase in cell number.

An observation was made indicating that the desired effect was short-lived. The following tests were conducted to evaluate this observation. In these tests (tables 9 and 10), plants were sprayed with 1 ppm 2,4-D at varying intervals. The results of these tests (tables 9 and 10) were less conclusive but did indicate that the effect of 2,4-D on increasing cell division was short-lived (compare the 14 + 21 days treatment with the 14 day treatment).

Table 8. Root and leaf weights, dry weight, hypocotyl diameter (HD), cell size and cell number of 26-day-old plants for differing treatment of 2,4-D.

	Leaves			Roots							
Treatment	Fresh Wt.	Dry Wt.	% D.W.	Fresh Wt.	Dry Wt.	% D.W.	Root/shoot Fresh	Root/shoot Dry	H.D.	Cell Size	Cells/ Radius
	g	g		g	g					$X10^{-9}$	
0.0 ppm	2.42	.223	9.24	.280	.0328	11.7	.127	.161	124.8	1.09	76.2
0.1 ppm	2.40	.222	9.26	.291	.0346	11.9	.133	.171	127.3	1.05	79.5
1.0 ppm	2.14	.199	9.28	.320	.0390	12.2	.164	.215	133.6	1.14	82.0
10.0 ppm	1.44	.120	8.34	.287	.0296	10.3	.215	.266	115.6	1.07	69.3
LSD (0.05)	0.23	0.23	0.57	.032	.0041	9.6	--	--	5.8	0.17	5.2

Note: Cell size and cell number were determined microscopically from cross sections.

Table 9. Root and leaf weight, dry weight, hypocotyl diameter (HD), cell size, and cell number of 28-day-old plants for treatments of 2,4-D at 1 ppm and repeat applications.

Date of Treatment (days after planted)	Leaves			Roots					
	Fresh Wt.	Dry Wt.	% D.W.	Fresh Wt.	Dry Wt.	% D.W.	HD	Cell Size	Cells/ Radius
	g	g		g	g			$X10^{-9}$	
None	3.09	0.516	16.7	0.57	0.152	26.7	193.2	1.54	135.2
14 and 21	2.96	0.464	15.7	0.65	0.153	23.5	194.0	1.60	137.4
14	2.73	0.415	15.2	0.59	0.148	25.1	184.5	1.77	135.2
21	2.95	0.519	17.6	0.62	0.164	26.4	199.3	1.73	139.4
14,16,18 21,23,25	2.83	0.427	15.1	0.65	0.140	21.6	173.4	1.60	122.9
LSD (0.05)	0.31	--	0.9	0.08	--	1.3	15.4	0.29	14.4

Note: Cell size and cell number were determined microscopically from cross sections.

Table 10. Root and leaf weights, dry weights, hypocotyl diameter (HD), cell size, and cell number of 21-day-old plants for treatments of 2,4-D at 1 ppm and repeat applications.

Date of Treatment (days after planted)	Leaves			Roots					
	Fresh Wt.	Dry Wt.	% D.W.	Fresh Wt.	Dry Wt.	% D.W.	HD	Cell Size	Cells/ Radius
	g	g		g	g			$X10^{-9}$	
None	1.91	0.193	10.1	0.28	.0406	14.5	124.2	1.77	82.5
14	1.86	0.206	11.1	0.29	.0447	15.4	142.5	1.57	91.4
14,16, and 18	1.78	0.180	10.1	0.32	.0442	13.8	137.7	1.63	88.1
LSD (0.05)	0.30	--	NS	0.04	--	NS	11.7	0.29	8.2

The repeated treatment every other day appeared to apply too much 2,4-D and caused a slight detrimental effect.

A pilot test was conducted in the field to evaluate the effect of repeated light treatments of 2,4-D in the field. The trial was planted July 7. Treatments began on August 1 and continued to September 13. The trial was harvested September 15. The heavy treatment (2/week) showed a slight visual effect of spreading the leaves in a more prostrate position. No visual effect was noted for the 1/week treatment. The harvest data (Table 11) indicate that one treatment per week had little effect on growth, but the two treatments per week had the same effect as on the seedlings in the greenhouse; i.e., a decrease in top growth and an increase in root growth. No attempt was made to measure cells in this test. The heavy treatment (2/week) interferred with the sugar reading, and we were unable to determine the sugar percentage.

Table 11. Top weight, root weight, and gross sugar for a control and two treatments of 2,4-D at 1/week and 2/week intervals. Each application was approximately 1/200 oz. 2,4-D per acre.

Treatment	Intervals	Top Wt/plot	Root Wt/plot	% Sugar
		g	g	
Control	--	9895	9517	12.0
2,4-D	1/week	9816	5700	11.7
2,4-D	2/week	9393	6968	--
LSD (0.05)		1336	1331	0.8

In summary the following conclusions were drawn:

a. Very light doses of 2,4-D cause an increase in root yield.

b. The point (concentration of 2,4-D) at which a positive effect is observed is very narrow. A slightly higher dosage causes harmful effects.

c. This increase in root yield was largely due to increases in cell division rate and not due to increase in cell size.

d. The photosynthate partitioning (root/shoot ratio) was altered by the 2,4-D treatments.

e. Positive effects of 2,4-D are short-lived.

2. IAA - In this test, plants were sprayed with concentrations of IAA, ranging from 10 ppm to 1000 ppm, two weeks after planting and at weekly intervals for 3 weeks. Plants were harvested, weighed, and sectioned for cell size measurements one week after the last application of IAA. IAA appeared to have a similar effect of 2,4-D in that it caused a decrease in leaf weight, an increase in root weight, and this increase was due to an increase in cell division rate (Table 12). Effects were small, however, and didn't reach significance.

Table 12. Hypocotyl diameter, leaf and root weight, cell size and cell number for plants treated with different concentrations of IAA.

Treatment	HD	Leaf Wt.	Root Wt.	Cell Size	Cells/ Radius
		g	g	$X10^{-9}$	
0 ppm	202.1	5.36	0.86	2.03	123.4
10 ppm	204.4	5.33	0.89	1.78	118.4
100 ppm	207.5	5.20	0.92	1.72	131.7
1000 ppm	201.2	5.12	0.93	1.96	123.6
LSD (0.05)	9.9	0.63	0.10	0.30	12.7

3. Dow 290 and Kinetin - Tests of these two hormones were conducted separately but are presented here together. These two tests were conducted in a similar manner as reported for 2,4-D and IAA, except cell size and cell number measurements were not made. Dow 290 is a herbicide similar to 2,4-D and had a similar effect; i.e., it increased root yield (Table 13). It didn't seem to have an effect on top yield except at high concentrations. This hormone is not as toxic at 2,4-D. Kinetin didn't give a consistent effect (Table 13); i.e., the data varied and showed no consistent trend.

Table 13. Hypocotyl diameter, top weight, and root weight of plants treated with different concentrations of Dow 290 and Kinetin.

Treatment	HD	Top Weight	Root Weight
Dow 290			
0 ppm	148.8	4.85	0.400
1 ppm	148.3	4.61	0.391
10 ppm	161.2	4.97	0.444
100 ppm	146.2	3.49	0.392
LSD (0.05)	8.3	0.43	0.039
Kinetin			
0 ppm	177.3	4.31	0.541
1 ppm	173.9	3.99	0.503
50 ppm	164.9	4.11	0.474
100 ppm	175.5	3.37	0.530
LSD (0.05)	11.0	0.39	0.057

The hormones tested thus far had an effect of altering the photosynthate partitioning by decreasing the amount going to the leaves and increasing that going to the root. The increased photosynthates translocated to the root were used for increasing the number of cells. While these trends were consistent, they were very small and slight increases in the hormone caused an adverse effect on the plant.

IV. GROWTH ANALYSIS

PARTITIONING PHOTOSYNTHATE FOR GROWTH AND SUGAR ACCUMULATION IN SUGARBEET

J. C. Theurer

The yield of sugar from a crop of sugarbeets is determined by both the size of the roots and the percentage of sucrose in these roots. Unfortunately, an inverse relationship is apparent between sugar content and root yield. Selection for high yield usually decreases sucrose and selection for high sucrose decreases root yield. Since this is a barrier to improvement of sugar production, it points out that we need more basic knowledge concerning the mechanisms and the controlling sites of photosynthate partitioning in order to make effective progress in the development of superior varieties.

Leaf initiation and top growth, root expansion and enlargement, and sucrose storage all compete for the same photosynthate supply. Partitioning to top growth, to root growth, and to sucrose accumulation varies continuously throughout the growing season and is dependent upon the relative sink strength of the plant parts. It is evident that the top receives the major part of the total available photosynthate early in the growth season, and the root receives most of the photosynthate during the latter part of the growth period. However, the influence of the sink strength of the root and that of the top for sucrose production is not readily apparent.

In 1977, we conducted a grafting experiment to determine the site of photosynthate partitioning and to compare the effect of the top versus the root on growth and sugar accumulation. Reciprocal grafts were made between L19, high-sugar inbred, C17, high-yield inbred, and a fodder beet Blanca which was obtained from Kleinwanzleben Sugar Company, Einbeck, West Germany. Data gave evidence that both the top and the root influence sucrose accumulation, but that the root had the greatest influence. (See 1977 Research Report, page B33). In this experiment, the plants were grown in 6-gallon buckets inserted into the soil in the field. This may have restricted root growth. In addition, a severe curly-top infection became evident in the field in August, and by harvest the top growth of all plants showed evidence of poor growth except those where C17 (moderate curly-top resistance) was used as the scion. Roots of severe curly-top infected plants were smaller than anticipated, and we felt the data concerning partitioning to top and root growth was not a valid comparison.

In 1978 we again made reciprocal grafts to study photosynthate partitioning. One experiment was conducted in the field and another in the greenhouse. The four genotypes listed in Table 1 were used for the field experiment.

Table 1. Characteristics of Genotypes used in Grafts - 1978 Field Experiment

Genotype	% Sugar	Root Size	Top Size
L19	High	Small	Small
C17	Medium	Large	Medium
Mangel	Low	Large	Medium
Chard	Medium	Very Small	Large

In the greenhouse experiment, a high-sugar hybrid (HS) 28F1, and a high-yield hybrid (HY) 28D52 were used in place of L19 and C17 inbreds, respectively.

Seed of each genotype was planted in 3 x 3 x 13 cm Japanese paper pots in greenhouse beds. Seedlings to be used as stocks in grafts were thinned to a single plant per paper pot. Ten-day-old seedlings were used as stocks and seedlings in the cotyledon stage of development were used as scions. Each graft was made by making a vertical cut through the hypocotyl of the stock seedling, inserting a wedge-shaped scion, then attaching a woman's hair clip to hold the scion firmly in place. The grafted beets were transplanted into soil in a 6-inch pot and a plastic bag was placed over the top of the pot to maintain a humid atmosphere until union of the graft occurred. Plants were kept under a constant grow-lux light for the first week following grafting. Approximately 10 days after the graft was made, when union had occurred, the leaves were completely trimmed from the stock, plants were grouped into replications and were watered with an equal volume of a complete nutrient solution.

Plants for the greenhouse experiment were transplanted June 9 into 6-gallon buckets and randomized in eight replications on ground beds in a single bay of the greenhouse. The temperature was maintained at 75-85 F. Plants were harvested August 2, 1978.

In the field test the grafted beets were removed from 6-inch pots June 2 and planted directly into the soil in the field on 30-inch centers. There were 28 replications in the experiment. This test was irrigated at weekly intervals and managed similar to other field trials. Harvest was made September 6-7, 1978.

Immediately after beets were dug, the tops were separated from the roots and weighed. Tops were then dried in a forced-air dryer for 96 hours and reweighed to obtain the weight of the dry matter in the tops. Roots were washed by hand, air dried to remove surface water, then weighed. Sucrose content of the roots was determined from a shredded sample of the root portion of each grafted beet. The standard cold-digestion polarization method was used for determination of sucrose percentage. A sample of shredded root tissue was dried to a constant weight in an oven maintained at 100 C and used to determine total root dry matter and the sucrose percentage in the dry matter of the root.

Results

In all cases the chard scions produced a small, knob-like crown on the root of all other genotypes. By contrast, the crowns of all genotypes tended to engulf the chard root, giving a shape similar to a large table beet. It was also visibly obvious that the mangel contributed to increased root size with all other genotypes.

Greenhouse Experiment.

The leaf number, leaf area, fresh and dry weight of leaves and roots, and the sucrose percentage for the crown and root portions are given in Table 2.

Table 2. Leaf area, top and root weight, and sucrose % for grafted beets - 1978 Greenhouse Experiment

	No. Lvs.	Leaf Area	Top Fresh Weight	Top Dry Matter	Tap Root Fresh Weight	Tap Root Dry Matter	Sucrose % Root Portion	Sucrose % Crown Portion
		cm	g	g	g	g		
Chard/Chard	20	5344	800	102	83	22	9.9	7.5
Chard/Mangel	19	3002	385	60	262	38	8.0	8.3
Chard/High Sugar	17	3907	583	77	250	46	12.3	10.1
Chard/High Yield	18	5080	708	86	263	45	11.5	8.5
Mangel/Chard	30	4269	572	79	470	64	7.4	7.6
Mangel/Mangel	30	4153	450	66	627	80	8.0	8.9
Mangel/High Sugar	24	3483	388	62	402	75	12.9	9.3
Mangel/High Yield	29	3923	440	67	508	88	11.5	8.9
High Sugar/Chard	50	6048	622	92	369	85	10.0	11.6
High Sugar/Mangel	40	4864	461	75	693	92	8.4	10.9
High Sugar/High Sugar	45	4208	399	72	386	81	14.7	13.5
High Sugar/High Yield	45	4950	510	84	457	85	12.8	12.9
High Yield/Chard	57	6198	647	98	353	52	9.5	9.9
High Yield/Mangel	42	4889	475	79	650	86	9.1	10.5
High Yield/High Sugar	46	5378	587	88	520	94	12.7	11.6
High Yield/High Yield	41	5569	571	88	561	98	11.7	11.5
Mean	34.5	4704	537	80	428	71	10.7	10.1
SE	9	935.5	143.7	12.8	116.3	17.1	1.02	1.26
LSD	10	926	142	13	115	17	1.0	1.2
CV	28.8	19.9	26.7	16.1	27.2	24.2	9.6	12.5

Grafts with the sugarbeet genotypes as scions produced a significantly greater number of leaves than grafts with chard or mangel scions, regardless of the root stock. The chard stock caused an increase in leaf number, leaf area, and top weight with scions from all other genotypes. Conversely, the stocks of all other genotypes reduced the size of chard tops compared to the homogeneous chard/chard grafts (compare 385, 583, 708, versus 800 grams top weight).

The scions of sugarbeet hybrids and the mangel had a greater effect on top growth than their stocks. Chard showed the opposite effect as the stock exerted the greatest change in the amount of assimilate that was proportioned to top growth. As expected, chard had significantly the largest top and the smallest root development of the four lines used in the experiment.

The HY homogeneous graft had the largest root weight. Scions of all other genotypes tended to reduce the root weight of HY. The HY hybrid scion increased the root size of HS (81 vs. 94 grams). The root size of chard was increased by scions of all other genotypes.

Both scions and stocks of the HS hybrid increased the sucrose percentage of the other genotypes. The HY hybrid decreased the sucrose percentage of HS, but increased sucrose percentage of mangel and chard grafts. The mangel significantly decreased sucrose percentages of the sugarbeet hybrids. Table 3 shows the relative effects of root and shoot on sucrose percentage. It is apparent that the roots were primarily responsible for determining the proportion of photosynthate that was partitioned to sucrose storage.

Table 3. Effect of root and shoot on sucrose percentage - 1978 Greenhouse Experiment

Genotype		Percent Change			
		HS	HY	Mangel	Chard
HS	Scion	--	+9	0	+5
	Stock	--	+9	+24	+61
HY	Scion	-14	--	-4	+14
	Stock	-13	--	+16	+44
Mangel	Scion	-16	-2	--	0
	Stock	-33	-19	--	-8
Chard	Scion	-12	-7	-25	--
	Stock	-43	-22	-19	--

Field Experiment

The fresh weight and the total dry matter of the tops for all graft combinations are given in Tables 4 and 5, respectively. Correlation between fresh weight and dry weight was 0.87. The top weights for homogeneous grafts are listed and underlined on the diagonal of each table. The columns of the table show the growth effects of the scion of a given genotype on the root stock of all other genotypes in the study. The rows in each table show the effects of top growth as influenced by a common stock genotype.

Table 4. Fresh weight (kg) of tops of grafted beets

Stock	Scion			
	Chard	Mangel	C17	L19
Chard	6.28	1.66	2.86	2.27
Mangel	3.49	1.61	2.00	1.53
C17	3.49	1.18	1.54	0.97
L19	2.35	1.09	1.56	1.18

Overall mean = 2.19 LSD = 0.70

Table 5. Total dry matter (g) of tops of grafted beets

Stock	Scion			
	Chard	C17	Mangel	L19
Chard	598	318	198	294
C17	391	219	151	153
Mangel	325	234	199	222
L19	258	203	149	180

Overall mean = 255.8 LSD = 69

As expected, the homogeneous chard graft had significantly the largest top at harvest. L19 high-sugar inbred developed the smallest top of

homogeneous grafts. The chard scion grew significantly slower on rootstocks of L19, C17, and mangel (3.49, 3.49, 2.35 versus 6.28), indicating that more photosynthate was being utilized for root growth than when the chard top was developed on its own rootstock. The chard stock caused an increase in top growth with scions of the other genotypes (e.g. 2.27 versus 1.18 for L19, Table 4). This demonstrates an internal mechanism in chard for partitioning more photosynthate for growth of the shoot, and also competition between plant parts of different genotypes for the available photosynthate. There was little effect on top growth when tops of the sugarbeet genotypes L19 and C17, or the mangel, were interchanged.

The effects that the root and shoot exert on partitioning of photosynthate to dry matter production in the top can be estimated from a comparison of the influence of the scions and stocks in reciprocal grafts. These effects are shown in Table 6. Values listed are the percent change in top growth due to different scions or stocks, compared to the growth of homogeneous grafts. In most instances, the scions or stocks influenced photosynthate partitioning; however, neither the root nor the shoot consistently exerted the greater influence on partitioning. In general, scions of chard and mangel had a greater influence than their stocks. L19 tended to show greatest influence due to stocks.

Table 6. Effects of root and shoot on top weight (dry matter basis).

		Chard	C17	Mangel	L19
Chard	Scion	--	+80	+63	+43
	Stock	--	+45	0	+63
C17	Scion	-47	--	+18	+13
	Stock	-35	--	-24	-15
Mangel	Scion	-67	-31	--	-17
	Stock	-46	+ 7	--	+23
L19	Scion	-51	-30	-12	--
	Stock	-57	- 7	-25	--

The root portion fresh weight and dry weights are shown in Tables 7 and 8. Correlation between these weights was .98. The mangel homogeneous graft had the largest root weight and chard homogeneous graft had the smallest root weight. All four genotypes were significantly different in their root weight on both a fresh weight and a dry weight basis. Almost all of the reciprocal grafts were significantly different. Both the scions and the stocks had some influence on root weight. The mangel stocks greatly increased the root weight of a plant regardless of the scion top (Compare the first-row weights in Tables 7 and 8 with weights of homogeneous grafts down the diagonal of the respective table.) From the standpoint of the effect of the scions, C17 scion increased, L19 decreased, and chard had little effect on the root weight of the mangel. Neither mangel, C17 or L19 scions increased the root weight when they were grafted to chard stocks (Compare weights on last row of each table).

Table 7. Fresh weight (g) of roots of grafted beets

Stock	Scion			
	Mangel	C17	L19	Chard
Mangel	1160	1746	872	1165
C17	408	639	470	391
L19	333	480	317	476
Chard	115	149	122	178

Overall mean = 563.8 LSD = 149

Table 8. Total dry matter (g) of roots of grafted beets

Stock	Scion			
	Mangel	C17	L19	Chard
Mangel	138	216	123	174
C17	65	110	90	68
L19	59	85	66	91
Chard	20	27	36	33

Overall mean = 87.5 LSD = 29

The comparative effects that the root and shoot exert on partitioning photosynthate for root growth were estimated by noting differences caused by scions or stocks, compared to the homogeneous grafts (Table 9). With the exception of C17 and mangel reciprocal grafts, the stocks had a significantly greater effect than scions in changing root weight. We can conclude from these results that the root sink strength is primarily responsible for determining the amount of total photosynthate that is partitioned to the roots.

Table 9. Effects of root and shoot on root weight (dry matter basis)

		% Change			
		Mangel	C17	L19	Chard
Mangel	Scion	--	-41	-11	139
	Stock	--	+96	+86	+427
C17	Scion	+56	--	+29	- 18
	Stock	-53	--	+36	+106
L19	Scion	-11	-18	--	+ 9
	Stock	-57	-23	--	+176
Chard	Scion	+26	-38	+38	--
	Stock	-86	-75	-45	--

Sucrose percentage in the fresh roots and sucrose percentage in the root dry matter for reciprocal grafts is given in Tables 10 and 11. Correlation between sucrose on a fresh and dry matter basis was 0.91. On a fresh weight basis all four homogeneous grafts were significantly different in their sucrose percentage. On a dry weight basis L19 and C17 were significantly higher in

sucrose content than chard or the mangel beets. L19 increased sucrose percent as both scion and stock for all other genotypes. C17 decreased sucrose content of L19, but increased the sucrose percentage of chard and mangel. The mangel root greatly reduced sucrose percentage regardless of the genotype used as scion.

Table 10. Sucrose percentage in roots of grafted beets

	Scion			
Stock	L19	C17	Chard	Mangel
L19	16.3	13.3	13.4	13.2
C17	13.0	11.5	11.8	11.0
Chard	10.9	8.7	9.4	8.2
Mangel	8.4	6.9	6.8	5.9

Overall mean = 10.5 LSD = 1.1

Table 11. Sucrose percentage of total dry matter in roots of grafted beets - 1978 field experiment

	Scion			
Stock	L19	C17	Mangel	Chard
L19	73.6	72.4	71.8	69.1
C17	68.9	66.9	72.1	68.5
Mangel	59.0	56.3	52.3	46.7
Chard	52.6	49.3	49.1	52.1

Overall mean = 61.3 LSD = 7.5

The effects of the root and shoot on partitioning photosynthate were estimated from the effects of scions and stocks in the reciprocal grafts (Table 12). With one exception (chard-mangel grafts) the stock was significantly most important in effecting change in sucrose content. We can conclude that the root is the site and has greater influence than that of the top in partitioning of photosynthate for sucrose storage.

Table 12. Effects of root and shoot on sucrose percentage in total dry matter

		% Change			
		L19	C17	Blanca	Chard
L19	Scion	--	+ 3	+13	+ 1
	Stock	--	+ 8	+37	+33
C17	Scion	- 2	--	+ 8	- 5
	Stock	- 6	--	+38	-41
Blanca	Scion	- 2	+ 8	--	- 6
	Stock	-20	-16	--	-10
Chard	Scion	- 6	+ 2	-10	--
	Stock	-29	-26	- 6	--

Discussion

Three reciprocal grafting experiments, made with diverse yield and sucrose genotypes, have demonstrated that partitioning of assimilate in the sugarbeet is determined by both internal controls and by competitive interaction of root and top sink strengths. Similar results were observed in sugarbeet-chard grafts by Thorne and Evans (1) and Rapaport and Loomis (2).

Both the root and the shoot have an influence on the photosynthate partitioning mechanism. However, our experiments showed that the root is primarily responsible and has the greatest influence on partitioning of photosynthate for root growth and for sucrose storage. Recent experiments by Wyse (unpublished data) support the conclusion that the major site for partitioning of photosynthate to root growth versus sucrose storage is within the root. He found that increasing photosynthate supply by CO_2 enrichment, increased total dry matter production, and decreasing photosynthate supply by shading decreased total dry matter production. Neither treatment, however, altered the partitioning between sucrose and non-sucrose dry matter in the root. These data suggest that maximum sucrose production will be achieved when we can alter the partitioning of photosynthate within the root so as to increase the ratio of sucrose to non-sucrose dry matter.

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THE EFFECT OF PHOTOSYNTHATE SUPPLY ON PARTITIONING WITHIN THE ROOT SINK OF SUGARBEET (Beta vulgaris)

Roger Wyse

Introduction

In recent years a major research effort has been directed toward improving photosynthetic efficiency in agronomic plants. As yet these studies have revealed little promise for improving plant productivity by increasing photosynthetic rates per se either through chemical or genetic manipulation. Receiving less research emphasis, but of major importance, is the allocation of photosynthate between sink regions within the plant. The ability of a plant to partition a high proportion of fixed carbon into the economically important sink is an important and genetically controllable factor (Synder et al. 1978). Although source-sink relationships are not well understood, there is considerable evidence that the ability of the sink to absorb photosynthate may play an important role in regulating rates of photosynthesis. For example, in grafting studies, when the high capacity root sink of sugarbeet was grafted to the spinach beet top, net assimilation rates were enhanced over that of spinach beet tops on spinach beet roots (Thorne and Evans, 1964). In short-term experiments, Swanson (1978 personal communication) has shown that the photosynthetic rate of source leaves increases as the size of the source is decreased. In short-term studies by Servaites and Geiger (1974), translocation rates increased in proportion to photosynthetic rates. Therefore, it would appear that the photosynthetic and translocation systems are not normally limiting productivity in sugarbeet.

In sugarbeet the economically important product is sucrose. Therefore, it is the objective of agronomists and genetists to maximize the sucrose content of the root. Based on growth chamber experiments, Ulrich (1954) proposed that only excess photosynthate above that required for structural growth of the root sink is stored as sucrose. However, modeling work by Fick et al. (1975) would indicate that the mechanisms controlling partitioning within the root sink for sucrose or non-sucrose structural carbohydrates is not well understood. Our objective was to determine the effect of photosynthate supply on the partitioning of sucrose within the sugarbeet plant.

Photosynthate supply can be regulated in field experiments by manipulating ambient CO_2 and light levels within the sugarbeet canopy. The CO_2 effects on plant productivity are well understood and are used on a commercial scale to increase greenhouse production (Wittwer, 1964). In growth chamber experiments with sugarbeet, Ford and Thorne (1967) found that increasing CO_2 levels to 1000 ppm increased photosynthetic rates in sugarbeet by 40%. This enhanced photosynthate supply increased root weight in preference to top weight. However, the differences were relatively small. Watson et al. (1972) showed that shading of sugarbeet plants throughout the growing season did not change the partitioning of sucrose in the root between sugar storage and structural dry matter. In studies reported here, CO_2 enrichment and shading in the field were used to manipulate photosynthate supply, and the effect on photosynthate partitioning within the root determined.

Materials and Methods

An adapted sugarbeet cultivar (AH-10, Amalgamated Sugar Company) was planted on May 12, 1978 with 55 cm rows. The plants were thinned on June 13 to a spacing of 10 cm within the row. All fertilizer was applied preplant as 1050 kg/ha of 16-20-0 (N-P-K). The plots were irrigated to field capacity at weekly intervals from emergence until approximately three weeks prior to harvest. On July 12 shading and CO_2 enrichment treatments were initiated.

Shading Experiment. Black nylon mesh having a 50% shading efficiency was suspended 75 cm above the soil surface with 1/8-inch steel cables on wooden posts. Treatments were arranged in a randomized block design with 8 replications. The plots consisted of three rows 5 m long running east and west. Only the north two rows were harvested. The percent shading was determined on a clear day, at approximately solar noon, using an Eppley Light Meter.

CO_2 Enrichment Experiment. Two-row plots 5 m long were surrounded (top open) by 1 m high, 0.1 mm thick natural polyethylene plastic on wooden frames. Cross baffles of polyethylene were installed at 1.5 m intervals within the chambers to retard mixing of the enriched atmosphere with outside air. CO_2 was generated in a chamber (2 m^3) containing a propane fired CO_2 generator (Stuppy Greenhouse Supply) and a centrifugal fan with a delivery of 27 m^3/min of air. The fan and generator were controlled by a time clock to operate between 800 and 1800 hours. The CO_2 enriched air was distributed to the individual chambers through a central wooden duct connected to 4-inch perforated plastic tubes (black plastic drainage "tile") down the center of each plot. To supplement the level of CO_2, fifty pounds of dry ice were added daily to the mixing chamber at 900 hours. The combination of the CO_2 generator and the dry ice maintained an atmosphere of 600 to 850 ppm within the plant canopy between 800 and 1800 hours. A complete air exchange within the plant canopy occurred approximately every two minutes. CO_2 levels both in the distribution system and in the plant canopy were measured by gas chromatography.

The plots were hand harvested on October 25. Measurements of root and top fresh weights were made in the field. Subsamples for determining the dry matter content of tops were obtained at that time. The roots were analyzed for sucrose content by polarimetry using the cold digestion technique used by the sugarbeet industry. Root dry matter was determined on a pulp sample obtained with a Spreckels Saw. All dry weights were determined after drying to constant weight at 100 C.

Data were analyzed using a randomized complete block design. Means followed by one asterisk were significant at the 5% level. Those followed by two asterisks were significant at the 1% level.

Results

Reducing incident radiation by 50% reduced total dry matter production by approximately 31% (Table 1). Root dry weight was reduced 38%, and as a result, the root-shoot ratio (R/S) was slightly lower in the control. Therefore, shading reduced the amount of photosynthate allocated to the root and also changed the partitioning ratio between root and shoot. The reduction in

R/S due to shading is a typical response to shading found in many plants. The apparent mass of the tops was visually greater in the shaded plants, leaves were larger and petioles were longer. However, the fresh weight differences were not nearly so apparent on a dry weight basis.

Table 1. Effect of (50%) shading on dry matter production of field grown sugarbeets.

	Total	Root	R/S
	kg/plot		
Control	9.4	5.4	1.46
Shaded	7.2	3.9	1.23
	**	**	**

The dry matter content of the shaded roots was slightly, although non-significantly lower than that of the control (Table 2). Sucrose contents on a fresh weight basis were not significantly different. Sucrose content on a dry weight basis is an index of partitioning between sucrose and non-sucrose dry matter within the root. The sucrose contents on a dry weight basis were not significantly different between the two treatments. Therefore, reducing the photosynthate supply by shading did not alter the partitioning of sucrose within the root.

Table 2. Effect of shading (50%) on photosynthate partitioning within the root of field grown sugarbeets.

	Dry Matter	Sucrose Content	
		Fresh Weight	Dry Weight
	Percent		
Control	22.0	15.8	72.1
Shaded	21.6	15.8	73.0
	ns	ns	ns

CO_2 Enrichment. Increasing the ambient levels of CO_2 within the canopy increased total dry matter production by 29% (Table 3). Root dry weight was increased 32% but there was no difference in the R/S ratio. Therefore, the increased photosynthate supply enhanced dry matter production but did not alter partitioning between root and shoot.

Table 3. Effect of CO_2 enrichment on dry matter production of field grown sugarbeets.

	Total	Root	R/S
	kg/plot		
Control	10.2	5.9	.98
CO_2 Enriched	13.2	7.8	.93
	**	**	ns

Percent dry matter was not significantly different between the control and the CO_2 enriched treatment (Table 4). Sucrose content on a fresh weight basis was slightly higher in the CO_2 enriched treatment. However, on a dry weight basis, the sucrose contents were not significantly different. Therefore, enhancing the photosynthate supply to the root by CO_2 enrichment did not alter the partitioning of the photosynthate between sucrose and non-sucrose dry matter.

Table 4. Effect of CO_2 enrichment on photosynthate partitioning within the root sink of field grown sugarbeets.

	Dry Matter	Sucrose Content	
		Fresh Weight	Dry Weight
		percent	
Control	21.9	16.2	73.9
CO_2 Enriched	22.4	16.7	74.5
	ns	*	ns

Discussion

These data suggest that although root growth is directly related to photosynthate supply, the partitioning within the root is independent of this photosynthate supply. These results confirm those of Watson et al. (1972) which showed that reducing photosynthate supply by shading did not alter sucrose content of sugarbeet roots on a dry weight basis. Previous work by Wyse (unpublished results) showed an increase in sucrose content on a dry weight basis from May through August. However, after September 1, no additional increase occurred. His data indicate that the sucrose to non-sucrose dry matter ratio may be genetically controlled. Although sucrose content on a fresh weight basis continues to increase, photosynthate partitioning reaches a constant level. Enhancing photosynthetic rates of sugarbeet plants would be a technique to increase total root yield but would not enhance sucrose content. Since it is the desire of the sugarbeet processor to process a minimal tonnage of roots in order to recover a maximum amount of sucrose, it would seem logical that the plant breeder should attempt to manipulate photosynthate partitioning, and in particular, photosynthate partitioning within the root sink itself. The goal of such an approach would be to maximize the allocation of the translocated photosynthate for sucrose storage. It is clear that such attempts should concentrate on modifying the sucrose to non-sucrose ratio within the root.

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IMPORTANCE OF CELL SIZE AND VASCULAR DENSITY ON ALLOCATION OF CARBON IN SUGARBEET ROOTS

Roger Wyse

Introduction

The sugarbeet plant has a relatively simple vegetative source-sink system. The translocated photosynthate is stored without modification as opposed to more complex systems which produce starch or proteins in the sink region. Therefore, it is a good organism for studying source-sink relationships and photosynthate partitioning.

The objective of this research is to define the mechanism controlling photosynthate partitioning between sucrose and non-sucrose dry matter within the root sink of sugarbeet. Grafting studies between genotypes possessing varying potentials for sucrose storage indicate sucrose content, and the growth potential of the root sink is controlled in the root. Therefore, our studies have concentrated on sink metabolism.

Materials and Methods

Our approach is to use comparative morphological and biochemical studies of genotypes within Beta vulgaris. The genotypes used are as follows:

1. Experimental high sugar hybrid: High sucrose content but low root yield.

2. Commercial hybrid: Intermediate sucrose content and intermediate yield.

3. Fodder beet: Low sucrose content and high root yield.

Sucrose content on a dry weight basis is an index of photosynthate partitioning between sucrose and non-sucrose dry matter within the root sink. The genotypes selected for study demonstrated considerable differences in their ability to store a high percentage of the translocated photosynthate as sucrose (Table 1).

Table 1. Root sucrose contents of the genotypes at maturity

	Fresh Weight	Dry Weight
	percent	
High Sugar	17.9	72.4
Fodder	8.9	63.5
Commercial	16.7	70.2

All plants utilized in these studies were field grown. Specific methods are listed with the appropriate table or figures.

Results

Comparative Morphology. The genotypes capable of storing high levels of sucrose have more vascular rings and relatively narrow bands of interzone parenchyma tissue between rings. In contrast, the high yield genotypes have fewer vascular rings and wide bands of interzone parenchyma tissue (Figure 1). These differences exist throughout the growing season (Figure 2). The wider rings of the fodder beet root are a result of both an increase in the number and size of cells (Figure 3).

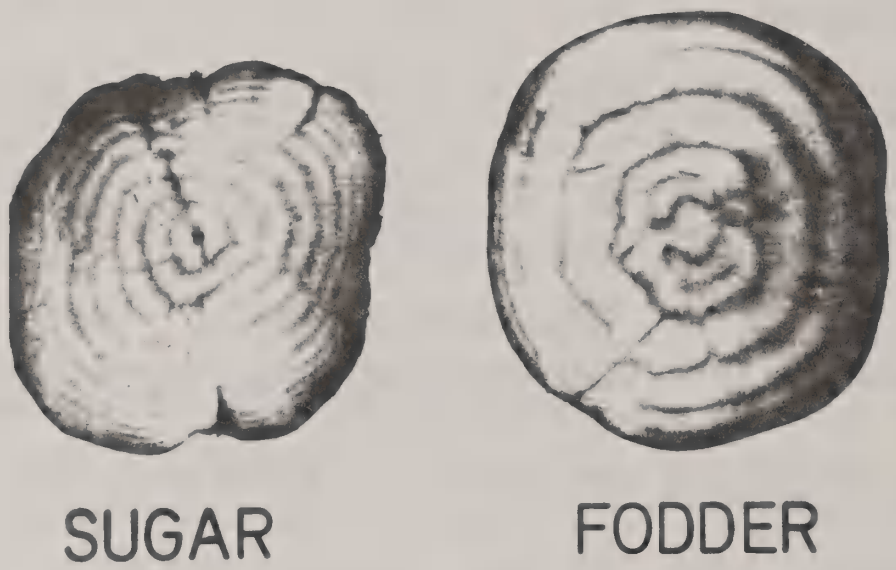

Figure 1. Cross-sections of sugarbeet (high sucrose) and fodder beet (low sucrose) roots. Note greater number of rings and narrower bands of interzone parenchyma in the sugar types.

Therefore, genotypes capable of partitioning a high portion of the translocated photosynthate for sucrose storage have small cells, more vascular rings and narrow bands of parenchyma cells between vascular rings.

Localization of Sucrose. Most of the sucrose stored in the root sink is localized in the parenchyma cells near the vascular bundles (Figure 4). The interzone parenchyma cells are lower in sucrose than parenchyma cells near the vascular bundles. The sucrose content of the interzone cell is inversely related to its distance from the vascular bundle. Interzone parenchyma cells contain higher levels of potassium, amino acids and reducing sugars than cells near the vascular bundle. This difference in cellular composition is particularly apparent in the fodder beet.

The differential composition between vascular and parenchyma tissue is apparently the result of an osmotic adjustment. The soluble solids content of the interzone cells is lower than that of cells near the vascular bundle (Table 2); however, osmotic concentrations in the two areas were not significantly different. Therefore, the depressed sucrose content in the interzone cells

is replaced by potassium, amino acids and reducing sugars. The osmotic concentration of root cells is not fixed but increases throughout the growing season as sucrose content increases. The osmotic concentration also varies between genotypes in direct relation to their sucrose content (Figure 5). The root water potential decreases with increased sucrose content primarily as a result of a greater osmotic potential. Turgor remains essentially constant. Therefore, osmotic concentration does not limit the amount of sucrose that can be stored.

Table 2. Evidence for osmoregulation between vascular and parenchyma tissue

	Vascular	Interzone Parenchyma	
Osmolality, mmols/ml			
High Sugar	.658	.676	ns
Fodder	.389	.352	ns
Commercial	.622	.593	ns
Soluble Solids, mg/ml			
High Sugar	204	190	*
Fodder	107	75	*
Commercial	210	210	ns

The distribution of sucrose between the free space, cytoplasm and vacuole was determined using compartmental flux analysis (Table 3). The fodder beet maintained a slightly greater proportion of sucrose in the free space (FS) and less in the vacuole than did the other genotypes. However, it is clear that the majority of sucrose is stored in the osmotic compartment (cytoplasm and vacuole).

Table 3. Compartmentation of sucrose in root cells of three Beta vulgaris genotypes

	Total	FS	Cyto	Vacuole
	mg/gm	percent		
High Sugar	142	14	12	74
Fodder	53	20	12	68
Commercial	127	15	12	72

Sucrose Uptake from the Apoplast. No differences were observed between genotypes in their ability to accumulate sucrose from a 5 mM solution (Table 4). In fact, on a cell surface area or a per cell basis, fodder beet was capable of absorbing sucrose at a faster rate than were the sugar types. Sucrose uptake from the apoplast into the vacuole of storage parenchyma cells is directly proportional to the concentration of sucrose in the free space between 5 and 500 mM concentration (Figure 6).

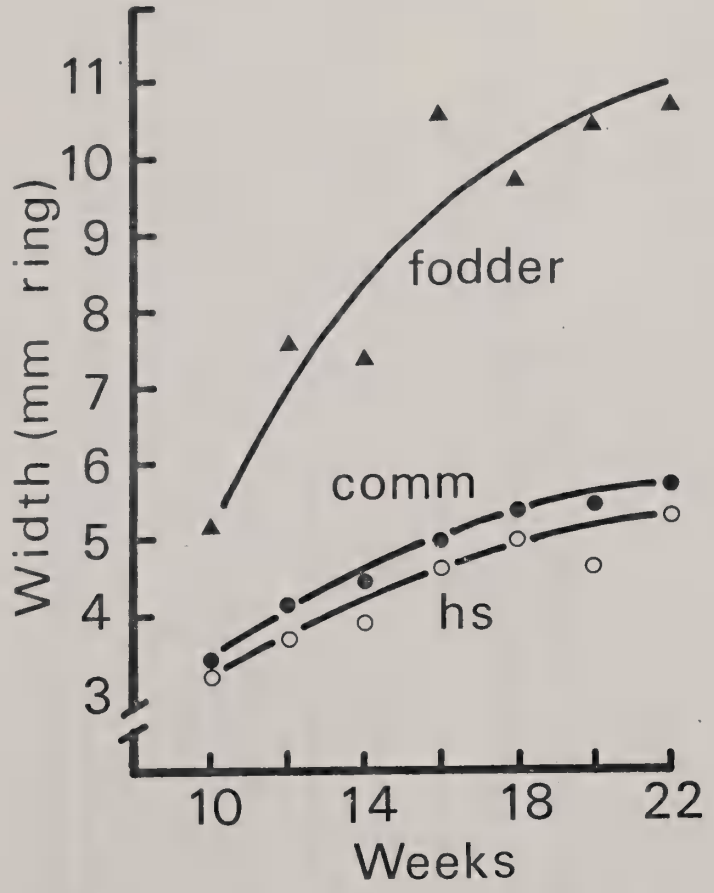

Figure 2. Mean width between vascular rings of three Beta vulgaris genotypes during a 22-week growing season.

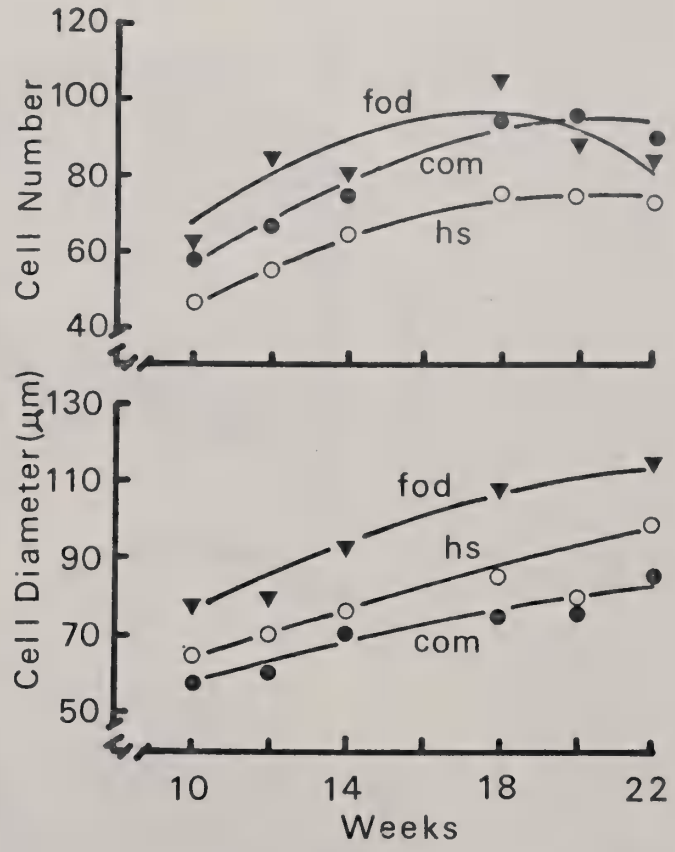

Figure 3. Mean cell diameter and number of cells between vascular rings 2 and 3 of the tap root of three genotypes of Beta vulgaris during a 22-week growing season. Cell size was determined by direct measurement in prepared tissue sections by light microscopy.

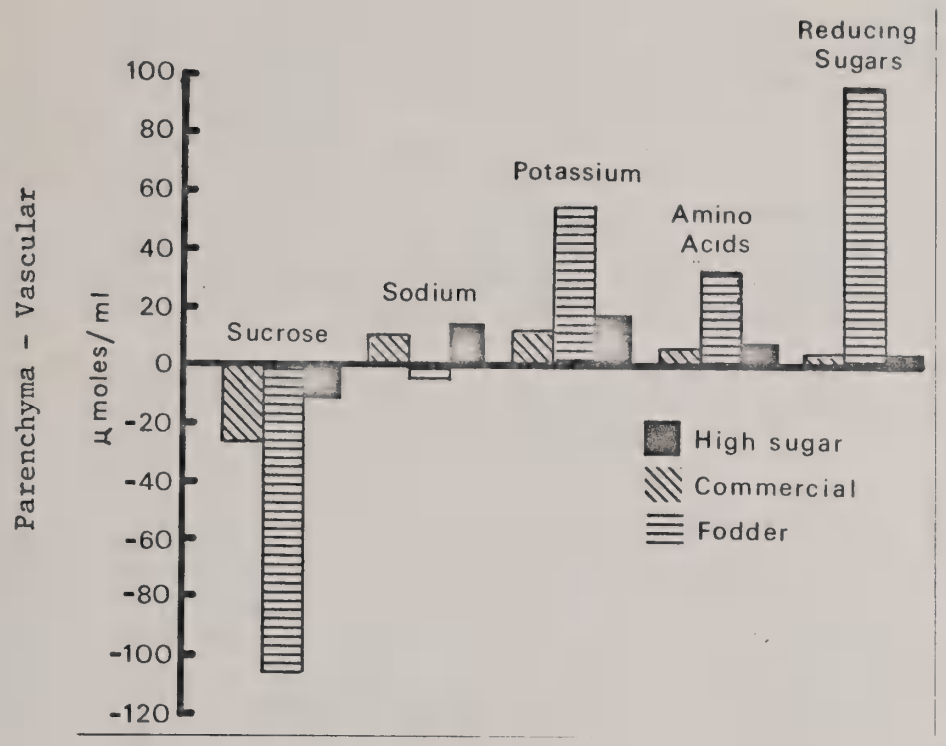

Figure 4. Differences in chemical composition between vascular and parenchyma tissue in three Beta vulgaris genotypes.

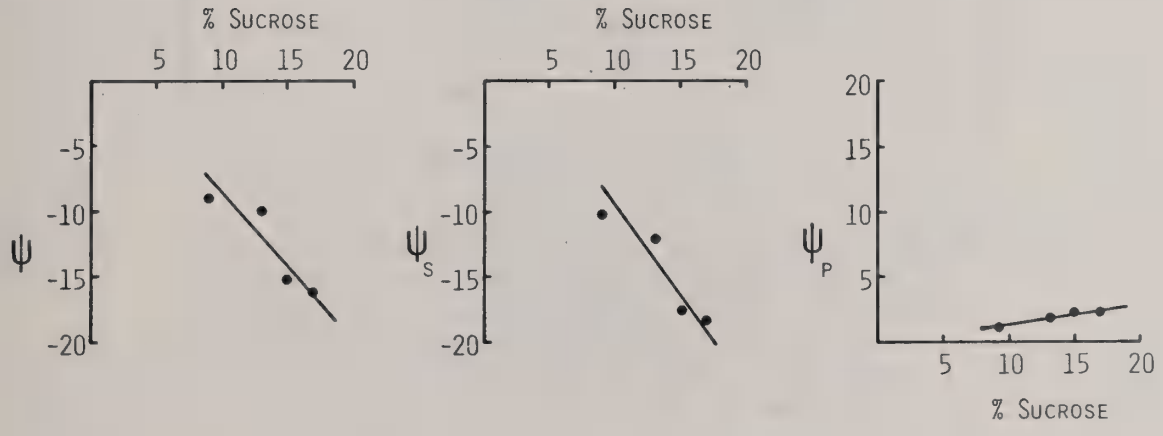

Figure 5. Total, osmotic, and turgor potentials in roots of four Beta vulgaris genotypes. Potential measurements were made using psychrometric techniques on tissue cores (4 mm x 5 mm). Tissue was a mixture of vascular and interzone parenchyma cells.

Table 4. Combined sucrose uptake into cytoplasm and vacuole by root disks from a 5 mM sucrose solution

	Uptake*
High Sugar	317
Fodder	325
Commercial	317

Temp. 25 C, .005 m sucrose

*nmols/2 hr/20 disks

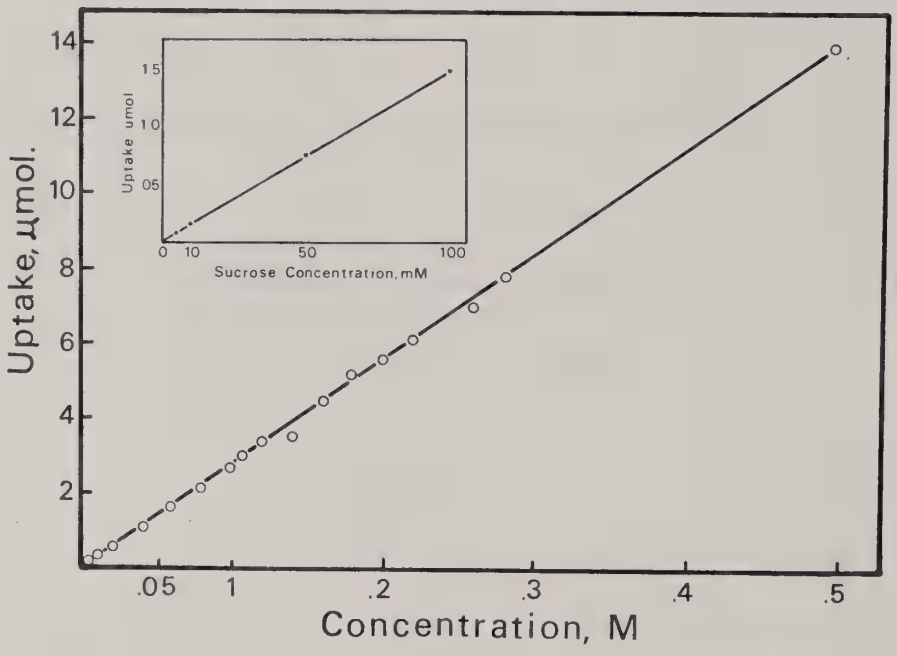

Figure 6. Relationship between concentration and rate of sucrose uptake by disks of sugarbeet root tissue. Disks (1 x 4 mm) were incubated for 3 hours in aerated media, washed to remove free space sucrose and the total counts remaining in the tissue determined.

Conclusions

Cell size and distance between vascular rings play a key role in determining the partitioning of photosynthate between sucrose and non-sucrose dry matter in the roots of Beta vulgaris. Small cells and narrow rings would have the folowing effects:

1. Increase the amount of cell wall per unit volume of tissue thus reducing the diffusive resistance within the apoplast. This lower

resistance coupled with a shorter diffusive path would expose a greater proportion of the cells within the sink region to high concentrations of sucrose in the free space.

2. Osmotic volumes are decreased and, therefore, osmotic concentrations are more easily adjusted. A lower osmotic volume would limit "storage space" if the osmotic potential were limited to a fixed value. However, as the data indicate, there is an osmotic adjustment within the tissue throughout the growing season. Therefore, sucrose storage is not limited by osmotic concentration.

3. A disadvantage of small cells may be an increased maintenance respiration resulting from higher osmotic gradients and greater volume of cytoplasm. A second disadvantage is the greater amount of dry matter allocated to cell wall.

Since uptake of sucrose is proportional to the external sucrose concentration, photosynthate partitioning between sucrose and non-sucrose dry matter in the root sink can be explained in large part by cell size and diffusive resistance (Figure 7). Those genotypes having small cells and narrow rings have a high proportion of cells in areas near the vascular bundles where free space sucrose concentrations are highest. The additional sucrose absorbed as a result of these higher external sucrose concentrations is stored in the vacuole.

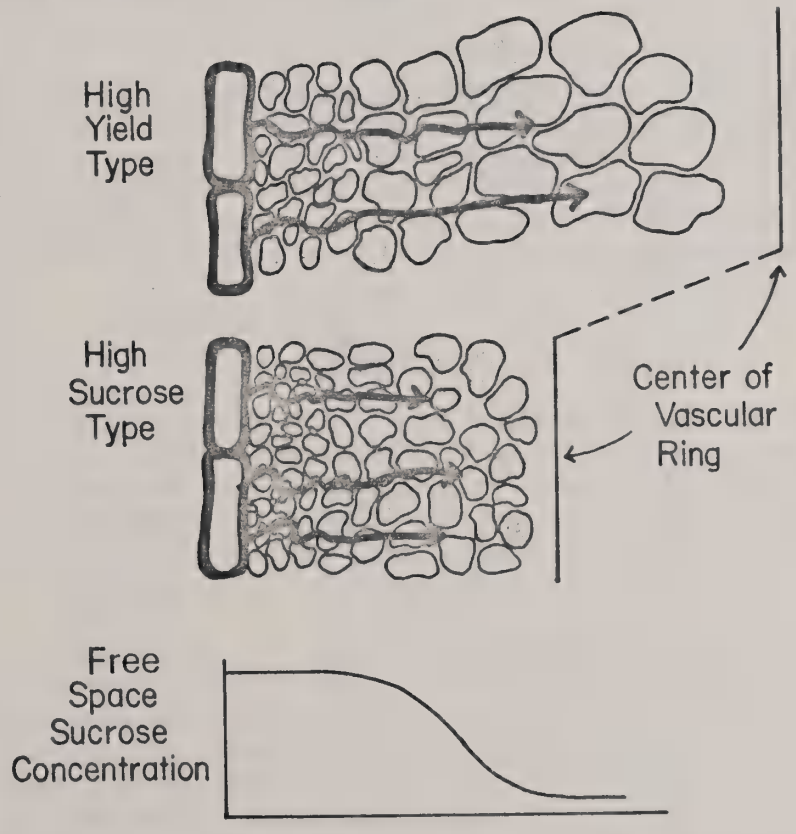

Figure 7. Illustration of cell size-ring width effects on sucrose partitioning within the root sink of Beta vulgaris.

SEASONAL ACCUMULATION RATE FOR HIGH SUCROSE GENOTYPES

J. C. Theurer and D. L. Doney

There is a marked difference in genotypes for sucrose percentage on a fresh weight basis. Lines that have high sucrose content early in the growing season generally are the ones that exhibit high sucrose at harvest in October (see 1976 Research Report, p. B43-B50). L19 inbred, a high sugar genotype, has shown a greater rate of sugar accumulation during the growing season than any other line we have tested. This line also contributes to increased sucrose in all hybrids where it has been used as a parent. In 1975 and 1976 June harvests, L19 had a lower sucrose percentage than several other lines. However, by September 1, the L19 inbred and L19 hybrids have shown significantly higher sucrose than any of the other lines being tested. The question is raised as to whether this behavior of the rate of sucrose accumulation is peculiar to the L19 genotype, or do other genotypes show similar behavior for sucrose accumulation.

High sucrose lines were obtained from USDA and sugar company sources and were compared at Logan in 1978. Ten hybrids and four inbreds were included in the field test in a split-block experiment with inbreds in one group and hybrids in another within each replicate. Two rows, (1 inbred and 1 hybrid), were seeded for a buffer between the inbred and hybrid units of each replicate. Individual plots consisted of two 22-inch rows 20 feet long with beets approximately 12 inches apart in the row. GWD2 and L20xL33 are high yield varieties that were included in the test as checks.

Twenty-four replicates were planted for each entry, and four harvests were made of six replicates per entry at each harvest. The dates of harvest were July 13, August 10, September 13, and October 12. Twenty competitive beets were taken from each plot at the first harvest for sucrose analysis, using the standard cold digestion pol method. Ten competitive beets were taken from each plot for each of the three subsequent harvests. Root weight sucrose percent and dry matter were also determined.

RESULTS

The root yield for the inbreds and hybrids is given in Table 1. There was a significant mean increase from 1.5 tons per acre at H1 to 15.5 tons per acre at H4. Significant differences in root yield were also noted between entries for each harvest. GWD2, L20xL33, and C17 had the highest root yield, as expected. Beta varieties also had relatively high yields. Root yield for H4 was affected by the degree of curly top disease of the respective entries.

Sucrose percent on a fresh weight basis is given in Table 2. Sucrose content increased in a somewhat linear manner. The rate of accumulation was greater the latter part of July and first part of August than it was during August and September. The four inbreds in the experiment showed similar patterns of sugar accumulation as was previously observed in 1975 and 1976 (Figure 1). L19 again showed lower sucrose percentage on the first harvest but had a far more rapid accumulation rate for the balance of the season than did L53 or F6. L53xL19 and 638R were the only hybrids that were consistently higher in sucrose percent than the two high yield checks, GWD2 and L20xL33. L53xL19 and ACH14 showed similar accumulation patterns with the greatest increase in percent sucrose from H1 to H2. L53xL19, Beta 1345, and 638R had the greatest increase

Table 1. Root weight by harvest (H) for 14 entries in sugar accumulation test, Logan, Utah. 1978.

Entry	Tons/Acre			
	H1	H2	H3	H4
Inbreds				
L19	0.99	3.92	9.36	12.29
L53	0.40	2.67	7.72	10.70
F6	1.00	6.26	14.62	16.12
C17	1.31	5.90	14.85	18.84
Hybrids				
L53xL19	1.84	5.98	12.94	15.86
GW72-MSH116	1.25	3.85	11.27	10.67
GW73-MSH187	0.95	4.18	11.90	13.75
Beta 1345	2.03	7.22	15.92	18.41
Beta 1237	2.16	7.78	16.69	17.25
AH12	1.74	5.61	12.10	16.38
ACH14	1.72	5.56	13.06	13.11
638R	1.74	6.59	13.86	15.04
L20xL33	1.88	7.69	14.09	20.43
GWD2	1.91	5.49	13.57	18.24
Mean	1.49	5.62	13.21	15.51
LSD 0.05	0.41	1.13	3.04	3.54
C.V.	24.05	17.15	19.91	19.77

Table 2. Sucrose percent of high-sugar inbreds and hybrids, Logan, Utah. 1978.

Entry	Sucrose %			
	H1	H2	H3	H4
Inbreds				
L19	8.3	13.5	14.7	18.8
L53	8.7	12.5	13.7	17.7
F6	9.1	12.0	13.2	16.3
C17	7.9	11.4	12.6	15.2
Hybrids				
L53xL19	9.2	13.1	13.8	17.6
GW72-MSH116	8.8	12.1	13.7	16.0
GW73-MSH187	9.3	12.9	13.8	16.6
Beta 1345	8.6	12.2	13.9	16.1
Beta 1237	9.8	12.5	14.4	16.8
AH12	9.3	12.2	12.9	16.7
ACH14	9.0	12.8	14.0	16.7
638R	9.6	13.1	14.2	17.8
L20xL33	8.6	12.1	12.3	16.2
GWD2	8.8	11.6	12.9	16.6
Mean	8.9	12.4	13.6	16.9
LSD 0.05	0.95	0.83	0.83	0.94
C.V.	9.2	5.8	5.3	4.8

in sucrose during the growing season (H1 to H4), being respectively 9.2, 8.2, and 8.5 percent. Beta 1237 and AH12 had the slowest rates of sugar accumulation of the hybrids, increasing respectively 2.7 and 2.9 percent between H1 and H2 and 7.0 and 7.4 percent between H1 and H4. The pattern of sucrose accumulation was generally similar for all hybrids. Figure 2 shows the accumulation pattern for high sucrose lines, 638R and L53xL19, for the high yield check, GWD2, and for the mean of all hybrids. The sugar accumulation patterns for all other hybrids, not plotted, would be between 638R and GWD2.

The sucrose percent of the dry matter increased on the average from 55% for H1 to 74% for H4 (Table 3). On the average, there was a 23% increase in D.M. sucrose percentage from H1 to H2, a 5% increase from H2 to H3, and a 6% increase from H3 to H4. Thus, the sucrose percentage in the total dry matter showed the greatest rate of increase between H1 and H2, as was observed for sucrose on a fresh weight basis. L19 had the lowest D.M. sucrose percentage at H1 and one of the highest percentages at H4. This inbred also showed the greatest rate of increase (30%) from H1 to H2 and, for the season, H1 to H4, (45%). Very few D.M. sucrose percentages were significantly greater, or less, than the overall mean at each harvest, and no entry consistently showed the highest, or the lowest, D.M. sucrose for the four harvests. Of note, was the observation that the high yield lines, GWD2 and L20xL33, had as high a D.M. sucrose percentage as L53xL19, or 638R; the hybrids having the greatest sucrose percentage on a fresh weight basis. Likewise, C17 (high yield) and L19 (high sucrose) inbreds showed no difference in sucrose on a dry weight matter basis.

Table 3. Sucrose percent of dry matter of high sugar inbreds and hybrids. Logan, Utah. 1978.

Entry	Sucrose % D.M.			
	H1	H2	H3	H4
Inbreds				
L19	52.0	67.7	72.2	75.7
L53	54.0	67.0	72.7	74.8
F6	56.0	68.0	69.3	73.8
C17	53.0	67.7	70.2	74.5
Hybrids				
L53xL19	57.0	68.5	70.2	74.5
GW72-MSH116	56.0	63.8	69.7	73.2
GW73-MSH187	55.0	65.3	67.2	71.8
Beta 1345	54.0	67.2	71.8	74.3
Beta 1237	60.0	68.7	73.5	73.0
AH12	57.0	67.7	70.2	75.3
ACH14	55.0	68.8	70.8	72.2
638R	55.5	68.2	70.5	74.5
L20xL33	57.0	67.7	70.5	75.8
GWD2	56.0	69.0	70.5	76.7
Mean	55.0	67.5	70.3	74.3
LSD 0.05	5.68	2.80	3.06	4.87
C.V.	8.88	3.59	3.77	5.68

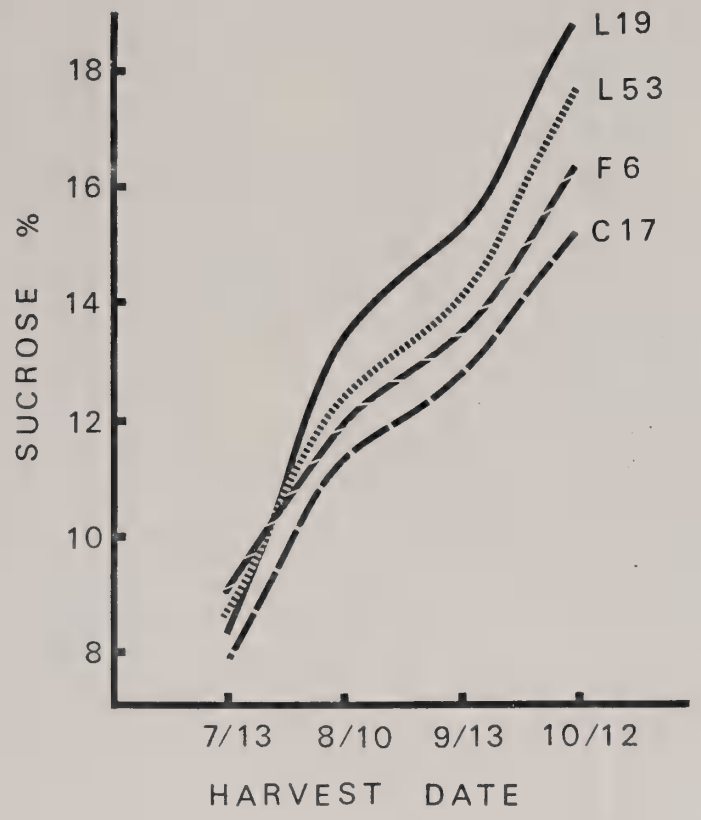

Figure 1. Seasonal accumulation of sucrose in inbred lines (fresh weight basis).

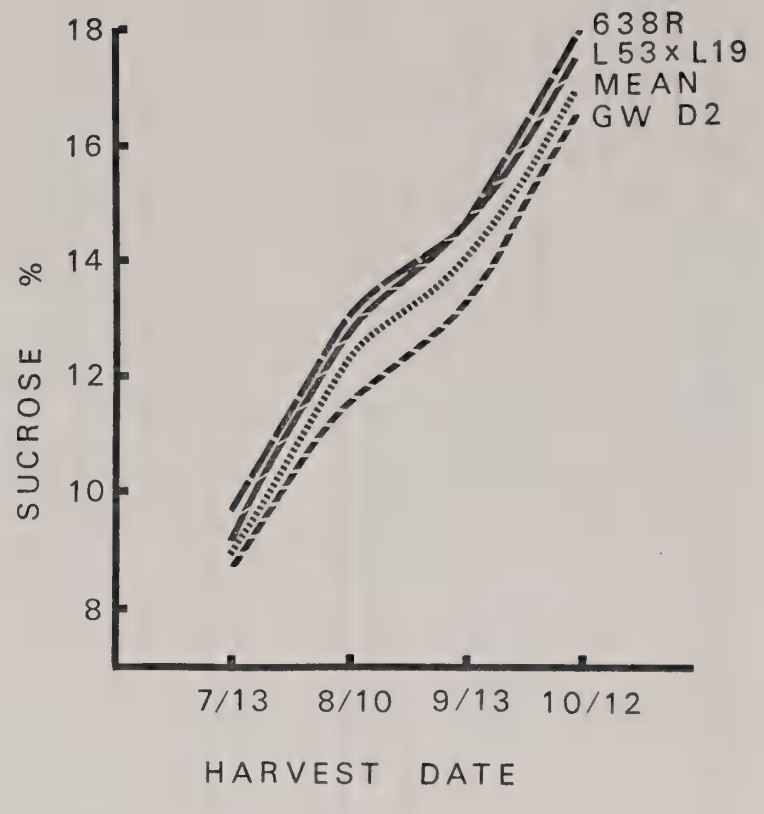

Figure 2. Seasonal accumulation of sucrose for two high-sugar hybrids, one high-yield hybrid, and the mean for 10 hybrids.

DISCUSSION

Results of this experiment confirm those of previous years. On a fresh weight basis, sucrose accumulation shows a linear pattern during the growing season, with the greatest rate of sugar storage occurring the latter part of July and the first part of August. On a dry weight basis, sugar accumulation is rapid during the above cited period and levels off for the balance of the season. Differences between sucrose and yield types are primarily due to the water content of the cells, since the D.M. sucrose percentage for the two types is very similar. High yield types have larger cells and more water in the tissues than sucrose types. The non-significance of D.M. sucrose percentage suggests that it would be difficult to select for high sucrose content on a dry matter basis. These data support other studies at the Logan Station which show that photosynthate is partitioned in the root to sucrose storage and root growth at approximately the same percentage, regardless of whether the genotype is a sucrose or yield type.

The sucrose accumulation pattern of L19 would indicate that it is probably genetically different than other sucrose lines. This was also inferred by previous studies wherein L19 was the only genotype that consistently showed high osmotic potential regardless of the stage of plant growth. Other genotypes only showed high-osmotic potential when beets were mature. The sugar accumulation pattern of L19 was not very evident in the L53xL19 hybrid in 1978. However, in 1976 tests, L53xL19 hybrid did show the typical extremely high rate of sugar accumulation at H2 versus H1, as consistently observed with L19 inbred.

V. INSECT RESISTANT STUDIES

SELECTION FOR SUGARBEET ROOT MAGGOT RESISTANCE

J. C. Theurer, C. C. Blickenstaff, and D. L. Doney

Selection for resistance to damage by the sugarbeet root maggot, Tetanaps myopaeforms was initiated in 1975 as a cooperative project of USDA-AR scientists at Logan, Utah, and Kimberly, Idaho. The third cycle of selection for high and low damage was made this year for two populations, 25A1 and 25D47.48.

High-damage and low-damage roots were selected from open-pollinated and selfed progenies in July 1977 in the root maggot nursery at Kimberly. Selfed and open-pollinated seed increases were made of the selected roots in the greenhouse and in isolation chambers at Logan during the winter of 1977-78.

Open-pollinated seed of 25D47.48 low damage, 25A1 low damage, 25A1 high damage, and the parent population were planted in the spring of 1978 at Kimberly in 3-row plots of 10-hill rows with hills 1 foot apart in the row. Entries were randomized in 20 replications. Five selfed progenies from plants showing low damage to the root maggot, and three selfed progenies from high damaged plants were compared in a second experiment. Entries were planted in a single 10-hill row with plants 1 foot apart in the row and replicated 20 times.

Maggot damage and vigor readings were made on all entries during the third week of July. Damage was visually rated by scoring roots on a scale of 1 (low) to 5 (high). Vigor was rated on a scale of 1 (poor) to 5 (good).

RESULTS

Damage and vigor ratings for the open-pollinated, selected population (3rd cycle), and the parent are given in Table 1. Selection was effective since both the low- and the high-damage selections were significantly different from the rating of the parent population. Selection for low damage in the third

Table 1. Root maggot damage and vigor ratings for open-pollinated populations. 1978.

Entry	Maggot Damage Rating	Vigor Rating
25D47-48 Low Damage	1.83	3.8
25A " "	1.79	3.6
25A1 High "	2.45	3.4
25A1 Parent	2.04	3.4
Mean	2.03	3.6
LSD	0.17	0.28
C.V.	13.3	12.4

cycle did not show additional improvement over that of the second cycle in relation to improvement in percent of the parent (Figure 1). This suggests that we may have reached a plateau using mass selection, and that other breeding methods that capitalize on non-additive genetic variation will be required for further

improvement in maggot resistance. The infestation in 1978 may have been less than that of previous years. The parent ratings in 1976, 1977, and 1978 were, respectively, 2.80, 3.08, and 2.02.

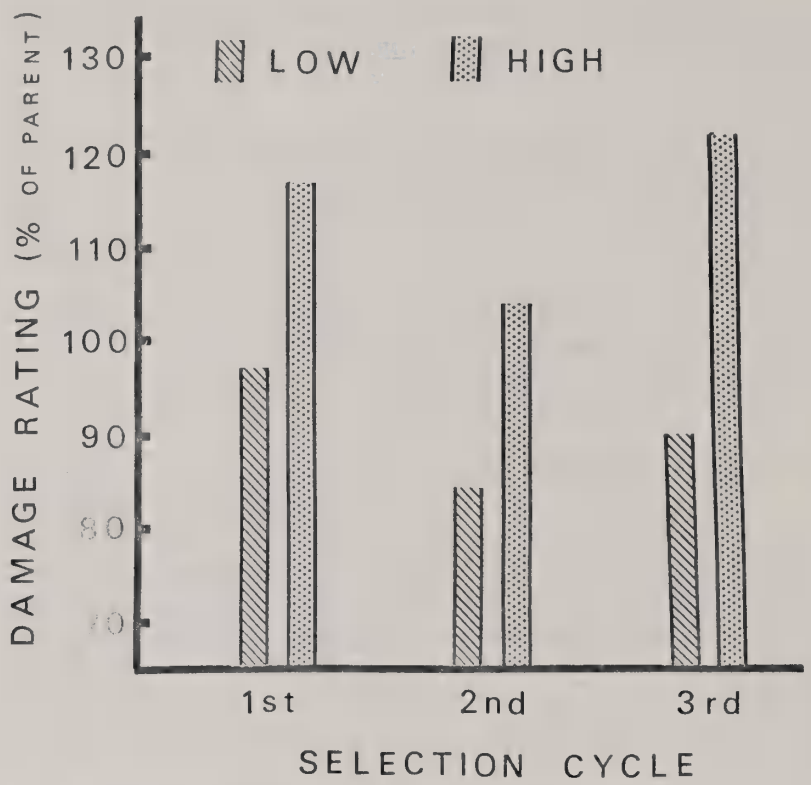

Figure 1. High and low selection for maggot damage in relation to original parent population.

Populations selected for low damage also exhibited better vigor than the parent population, or the high damage selection (Table 1). The correlation was -0.73 for vigor vs damage rating.

Maggot damage and vigor ratings for selfed lines are given in Table 2. The low-damage selections from the previous year had lower maggot ratings than the high-damage selections; however, only one selection, 40F9, was significantly different than the high-damage maggot lines. With one exception, 40G8, the low-damage selections, had significantly better vigor than high-damage selections. Correlation between these variables was -0.67. Stand was not good in these plots and, no doubt, had an influence on the amount of root maggot damage. There was an average of 6 plants per line in each replicate; however, plots ranged from 3 to 10 plants each.

Selection was also initiated this year in another heterogeneous population. Recurrent selection and inheritance studies on maggot resistance are planned for the next few years.

Table 2. Maggot damage and vigor ratings for selfed progenies selected for high and low damage - 1978.

Selfed Line	Maggot Damage Rating	Vigor Rating
40F1 Low Damage	2.12	3.4
40F6 " "	2.04	4.3
40F8 " "	2.09	3.6
40F9 " "	1.90	3.6
40G10 " "	2.16	3.4
40G6 High "	2.58	2.8
40G7 " "	2.72	3.4
40G8 " "	2.58	2.8
Mean	2.29	3.4
SE	0.61	0.52
C.V.	26.6	15.4

VI. SUGARBEET DISEASES

SYSTEMIC INSECTICIDE TREATMENT OF RESISTANT AND SUSCEPTIBLE SUGARBEETS TO REDUCE CURLY TOP

D. L. Mumford

During the past three years, there has been a rapid increase in the amount of acreage in the Intermountain Area planted with sugarbeet cultivars that are quite susceptible to beet curly top virus (BCTV). This has occurred because some susceptible cultivars have yielded higher than resistant cultivars in the absence of curly top. In 1977, sugarbeet growers were reminded of the severe losses BCTV can cause when a localized epidemic occurred in southern Idaho.

Systemic insecticides have been shown to be effective in controlling the sugarbeet leafhopper and reducing losses due to BCTV (1) (4). There is a need for information on whether systemic insecticide treatment would prevent disease loss in susceptible sugarbeets as effectively as host resistance does in resistant sugarbeets under severe curly top conditions. This study was undertaken to determine the comparative effectiveness of systemic insecticide treatment in reducing losses due to BCTV in a susceptible, a moderately susceptible, and a resistant sugarbeet.

MATERIALS AND METHODS

A susceptible cultivar (Beta 1345), a moderately susceptible cultivar (Great Western D-2), and a resistant cultivar (Amalgamated AH-12) were tested in a split-plot design. Main plots consisted of phorate (Thimet) at 1.3 lbs. active ingredient per acre applied 4" below the seed, aldicarb (Temik) at 2 lbs. active ingredient per acre applied as a 2-to-3-inch band at the seed level (Ruskin method), and an untreated check. Subplots consisted of four 25-foot rows of the three cultivars listed above. Main plots were replicated six times. The test was planted late (May 23, 1978) to favor the development of severe curly top symptoms. A severe curly top level was induced in the plots by methods previously described (3). Approximately 12,000 viruliferous leafhoppers were distributed throughout the plots on June 27, two weeks after thinning plants to one plant per foot of row.

On July 14 and on August 2, the percentage of infected plants in the center two rows of each subplot was determined. Thirty competitive roots (those having an adjacent root on either side) were hand-harvested from the center two rows of each plot on September 28. The roots were hand-topped, washed, weighed, and the sucrose percent was determined.

RESULTS

By August 2, maximum infection (99%) had been reached in the susceptible cultivar (Table 1). At this time, the reduction in infection in Thimet-treated plants over untreated checks of AH12, D2, and 1345 was 110, 64, and 71, respectively. Temik treatment did not consistently reduce infection. This was, undoubtedly, due to the ineffectiveness of the method of insecticide application used in this study.

Table 1. Effect of systemic insecticide treatment on curly top infection, root yield, and sucrose content of resistant and susceptible sugarbeets.

Variety	Treatment	Infection 7/14	Infection 8/2	Root Yield	Sucrose
		%	%	T/A	%
AH12	Thimet	17	30	11.8	16.77
(Resistant)	Temik	33	56	9.4	16.22
	Untreated	28	63	8.6	15.98
D2	Thimet	28	56	11.7	15.90
(Moderately	Temik	56	93	6.1	15.58
Susceptible)	Untreated	65	92	6.7	15.83
1345	Thimet	42	63	10.6	15.42
(Susceptible)	Temik	60	95	3.7	15.23
	Untreated	72	99	2.3	14.70
LSD (P = 0.05)				1.9	1.04

Thimet treatment below the seed resulted in significant increases in root yield over no treatment for all three cultivars (Table 1). As expected, root yield increase was greatest in the susceptible cultivar. The results show that, under conditions present during this study, below the seed application of Thimet increased root yield 32%, 75%, and 361% in AH12, D2, and 1345, respectively. Differences in root yield between the three cultivars treated with Thimet were not significant.

There were no significant differences in sucrose percent between insecticide treated and untreated plants of any of the three cultivars. However, AH12 had significantly higher sucrose than 1345; probably due to differences in curly top severity.

DISCUSSION

No attempt was made in this study to make direct comparisons, either between Thimet and Temik insecticides or between different methods of application with the same insecticide. Other studies (1) (2) have shown that Thimet, Temik and other insecticides are effective in reducing curly top losses. Each insecticide has advantages and disadvantages such as phytotoxicity, longevity of effectiveness, nematacidal properties, and cost. The application of Temik with the seed was included in this study to test an alternative to below the seed applications which some consider detrimental to good germination in the Intermountain Area.

Although this study shows that insecticide treatment offers considerable protection from curly top to both resistant and susceptible sugarbeets, some cautionary considerations should be kept in mind. The widespread planting of curly top susceptible sugarbeets will probably increase the threat of severe curly top disease years due to the increased presence of hosts that are excellent reservoirs for the virus. Environmental factors, such as temperature and moisture, influence the effectiveness of insecticides resulting in severe loss potential with a combination of susceptible host and failure of insecticide treatment.

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SUGARBEET RESEARCH

1978 Report

Section C

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CONTENTS

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION AND GERMPLASM RELEASES AND REGISTRATIONS, 1978

HECKER, R. J. and E. G. RUPPEL. Release of sugarbeet germplasm resistant to Rhizoctonia root rot. Official joint release of the USDA-SEA, Beet Sugar Development Foundation, and Colorado State University Experiment Station, February 28, 1978.

Five multigerm, rhizoctonia root rot resistant sugarbeet germplasms were released for use in breeding and variety development programs. All the germplasms are moderately resistant to cercospora leaf spot, they flower after a short induction (easy bolting), and they are largely self sterile.

FC 702/4 is a product of two cycles of recurrent selection for resistance to rhizoctonia root rot following four cycles of mass selection for resistance from a synthetic derived from an obsolete variety (GW 359).

FC 702/4 (4X) is the C_3 colchicine-induced tetraploid conversion of FC 702/4, without additional selection.

FC 705 is a rhizoctonia resistant synthetic developed by four cycles of recurrent selection for resistance from FC 701 (previous release) which had been developed by four cycles of mass selection from GW 674-56C (obsolete variety).

FC 706 is a heterogeneous strain, mass selected for resistance from the OP_2 generation of five diverse strains, all of which had been subjected to three to five cycles of selection for resistance. Characteristics among these five strains included black root, leaf spot, and botrytis resistance, monogerm, high root yield, high sucrose, and some genes from *Beta maritima*. The strain has potential for development of diverse rhizoctonia resistant strains.

FC 707 is a product of one cycle of selection for resistance from an interpollinated pool of superior progeny lines, each of which had been subjected to five cycles of selection. Their origins had been from high production experimental synthetics.

In inoculated field trials over 2 years, these five strains have exhibited good resistance to a highly virulent root-rotting strain of *Rhizoctonia solani*. FC 705 and FC 707 have resistance superior to the previously released strain FC 703. FC 702/4 and FC 706 have slightly less resistance than FC 703. These strains all have relatively good general combining ability as tested by a common set of male sterile testers. In the absence of rhizoctonia root rot, the sugar yield of these strains was below that of commercial varieties; hence, these strains are not released for grower use. These strains have potential as pollinators or sources of pollinators in hybrids, and as sources of genes for rhizoctonia resistance.

HECKER, R. J. and G. A. SMITH. Release of sugarbeet germplasm. Official joint release of the USDA-SEA, Beet Sugar Development Foundation, and Colorado State

University Experiment Station, February 28, 1978.

FC 704 is a diploid multigerm, red fleshed, rhizoctonia resistant sugarbeet. It is a product of three cycles of mass selection in both the vegetative and flowering stages for intensification of red color in roots and tops followed by two cycles of mass selection for resistance to root rot caused by *Rhizoctonia solani*. The roots, petioles, and leaves are deep red. The source of this line was a heterogeneous population known as the "German red beet," acquired about 1940 by the Great Western Sugar Company from the German firm Kleinwanzlebener Saatzucht AG. FC 704 has relatively high root yield, but has very low sucrose content and thin juice purity. The source population is the only *Beta vulgaris* germplasm found which has a significant amount of inherent resistance to rhizoctonia root rot. Other sugarbeet strains with similar levels of resistance have been derived only through intense breeding. This relatively high level of inherent resistance is the primary reason for release of this material. It is not known if the resistance in FC 704 is genetically the same as the resistance accumulated in previously released rhizoctonia resistant sugarbeet strains. In inoculated replicated tests, FC 704 had about 25% healthy roots compared with 0 to 3% in commercial hybrid varieties, and 50% in the most resistant developments from the Fort Collins breeding project. The source population of FC 704 has been used as a top cross general combining ability tester; FC 704 may be similarly useful. FC 704 is susceptible to cercospora leaf spot and curly top, and flowers after a relatively short induction.

SCHWEIZER, E. E. Control of broadleaf weeds in sugarbeets with glyphosate. Proc. Western Society of Weed Science 1978. 31:122.

Annual broadleaf weeds that escape cultivation and herbicidal treatments applied in sugarbeet compete with the crop. Since even low densities of weeds can reduce root and sucrose yields, we conducted field studies to determine the effectiveness of glyphosate [*N*-(phosphonomethyl) glycine] to control or minimize the competitiveness of low densities of common lambsquarters, kochia, and redroot pigweed. These weeds were spaced alternately within the row to achieve broadleaf densities of 0, 6, 12, 18, and 24 plants per 30.5 m of row. On June 23, glyphosate was sprayed 10 cm above the sugarbeet canopy with a recirculating sprayer at 1.7 kg/ha and at a volume of 187 L/ha. The average height of sugarbeets was 45 cm, common lambsquarters 85 cm, kochia 70 cm, and redroot pigweed 40 cm. Many redroot pigweed plants and a few other broadleaf plants, were not sprayed because they were not tall enough to intercept any spray. Of those that were sprayed, some died within 2 weeks and others continued to die slowly, until by late September, 58% of the common lambsquarters, 77% of the kochia, and 65% of the redroot pigweed had died. Less than 3.5% of the sugarbeet plants were injured by glyphosate and only 0.2% of those died. Weed competition was reduced significantly by glyphosate. Thus, root yields were reduced only 8, 10, 15, and 19% where the original densities were 6, 12, 18, and 24 plants per 30.5 m of row. In a comparable study in which these braodleaf weeds were not treated with glyphosate, root yields were reduced 20, 35, 43, and 54%, respectively.

STEINKAMP, M. P., S. S. MARTIN, L. L. HOEFERT, and E. G. RUPPEL. Ultrastructure of lesions produced by *Cercospora beticola* in leaves of *Beta vulgaris*. Accepted for publication in Physiol. Plant Pathol.

The fungus *Cercospora beticola* Sacc. incites a leaf spot disease of sugarbeet (*Beta vulgaris* L.). Lesion formation was studied by electron microscopy. One week after inoculation, the fungus was established in the intercellular spaces of the mesophyll and degenerative changes had occurred in cells near infection sites. Visible necrotic spots were produced as these lesions enlarged. During the degenerative sequence cell membrane systems and organelles were disrupted; affected cells quickly collapsed and became necrotic. After 3 weeks a boundary zone with two regions separated central necrotic tissue from apparently unaffected, healthy tissue outside the lesion. Two types of cell wall apposition occurred, one a localized callose-type in the lesion center, and the second a generalized wall thickening in the inner boundary zone. Electron-dense material occluded intercellular spaces in the outer boundary zone. During most phases of the disease, hyphae bridged intercellular spaces or were attached to and followed the contours of host cell walls. Only late in the disease, long after host cells were necrotic, were hyphae observed within largely disintegrated hostcell walls.

SMITH, G. A., R. J. HECKER, and S. S. MARTIN. The effects of ploidy level on the components of sucrose yield and quality in sugarbeet. Approved by SEA for publication in Crop Sci.

Comparisons of 2X, 3X, and 4X sugarbeet (*Beta vulgaris* L.) lines and hybrids were made to determine the effects of ploidy level on sucrose yield and quality components in equivalent and non-equivalent hybrid populations.

The relative order of importance for the components of recoverable sucrose was generally the same for all three ploidy levels, with root weight having the greatest path coefficient direct effect and juice purity the least.

Purity percent generally decreased as ploidy level increased; this purity decrease was accompanied by increases in the quantity of nonsucrose chemical components in the extract.

Significant differences were found between reciprocal equivalent 3X hybrids for both yield and quality components. Recoverable sucrose yield of triploids produced from tetraploid female plants [3X(4X♀)] averaged 17% greater than that of the reciprocal 3X(4X♂) hybrids. The same 3X(4X♀) triploid hybrids also were lower than their reciprocal equivalents in extract concentrations of Na, K, and total N, with decreases of 9%, 17%, and 12%, respectively. When components are expressed in mg per 100 g sucrose, the corresponding decreases were 13%, 20%, and 16%, respectively.

SMITH, G. A. Sugarbeet. Ch. 45. *In* Hybridization of Crop Plants. Am. Soc. Agron. Press, Madison, WI. Probable date of publication, April 1979.

The chapter describes the hybridization techniques used in sugarbeet research programs and in commercial hybrid seed production. Techniques

described include, plant culture, plant preparation for hybridization, special environmental requirements for floral induction and use of male sterility. A description of all wild relative species and their hybridization potential, and a complete listing of all identified genes of sugarbeet are included.

SMITH, G. A., E. G. RUPPEL, and J. O. GASKILL. Registration of sugarbeet germplasm with resistance to Cercospora or Cercospora and curly top. Accepted for publication in Crop Sci.

The following lines which have been described in their respective release documents were developed by the USDA, SEA, in cooperation with the Beet Sugar Development Foundation and the Colorado State University Experiment Station. All of the lines except FC 902 are monogerm. FC 902 is a multigerm line developed for resistance to cercospora-curly top and intended for use as a pollinator.

All of the lines with a 500 designation, i.e. FC 504, were developed for resistance to cercospora leaf spot. Lines with 600 designation, i.e. FC 605, were developed for combined resistance to cercospora and curly top. Germplasm lines and their registration numbers are as follows:

FC 902 (Reg. No. GP 41)
FC 504 (Reg. No. GP 42)
FC 504 CMS (Reg. No. GP 43)
FC 502/2 (Reg. No. GP 44)
FC 502/2 CMS (Reg. No. GP 45)
FC 506 (Reg. No. GP 46)
FC 506 CMS (Reg. No. GP 47)
FC 604 (Reg. No. GP 48)
FC 604 CMS (Reg. No. GP 49)
FC 605 (Reg. No. GP 50)
FC 605 CMS (Reg. No. GP 51)

Published Papers Abstracted in Sugarbeet Research, 1977 Report

HECKER, R. J. Recurrent and reciprocal recurrent selection in sugarbeet. Crop Sci. 18:805-809. 1978.

HECKER, R. J. and E. G. RUPPEL. Effect of pesticides and nitrogen fertility on rhizoctonia root rot of sugarbeet. J. Amer. Soc. Sugar Beet Technol. 20: 6-10. 1978.

SMITH, G. A. and S. S. MARTIN. Differential response of sugarbeet cultivars to Cercospora leaf spot disease. Crop Sci. 18:39-42. 1978.

RHIZOCTONIA ROOT ROT RESEARCH AND RESISTANCE BREEDING
(BSDF Project 20)

Rhizoctonia Field Research, 1978.--R. J. Hecker and E. G. Ruppel.

Our 1978 field research on resistance to *Rhizoctonia* in sugarbeet was conducted on our BSDF-leased farm where we also conduct the cercospora leaf spot field research. This was the first crop year of the 3-year renewed lease on the farm.

The area of the farm devoted to rhizoctonia root rot research is on a 4-year rotation (beets, barley, barley, fallow). Our 1978 experimental area was the first time we have returned to an area previously used for rhizoctonia research, which was 1974. There was a noticeable, but not a practically significant amount of infection by *Rhizoctonia* prior to inoculation.

The experiments in the rhizoctonia root rot test area were inoculated July 24 with a tractor-mounted 4-row granule applicator. The dry, ground barley-grain inoculum of *Rhizoctonia solani* (R-9) was broadcast in a band over each row at the rate of 8 grams per 6.1 m of row in a split application (opposite directions of travel for each application). One-row plots 6.1 m long and 56 cm apart were planted May 21. Thinning was done between June 12 and 20. The roots were lifted and individually rated for severity of rot between September 11 and 15. The disease index (DI) ratings were based on a scale of 0 to 7 (0 = no evidence of infection, 7 = plant dead and extensively decomposed). The percentage of healthy roots were those with DI ratings of 0 and 1.

Our root rot epidemic in 1978 was relatively mild compared to other years. However, significant death loss did occur in susceptible populations by harvest time. We feel that the assessments for disease resistance were adequate and accurate.

Our rhizoctonia research can be classified into three general categories.

1) Breeding for improved resistance and developing genetic information about resistance, and information on the utilization and incorporation of resistance into commercial hybrid varieties.
2) Studying the effect of various cultural practices and environmental conditions on the severity of root rot, and making applied recommendations in these areas.
3) Basic research on the pathogen itself and on interactions of pathogen with genotype, cultural practice, environment, etc.

Succeeding sections of this report relate our 1978 accomplishments in these categories.

Evaluation of Contributed Lines.--E. G. Ruppel and R. J. Hecker.

Separate randomized complete block designs with five replications were used to evaluate a total of 57 contributed lines from American Crystal, Great Western, Holly, and Utah-Idaho Sugar companies for resistance to *Rhizoctonia solani*. In each test, cultivars FC 703 and GW 674-56C, resistant and susceptible to *R. solani*, respectively, were included as checks. Results of each company's test were statistically analyzed and sent to company breeders, thus, they will not be reproduced here. The mean disease index (DI) across tests for cv FC 703 on a scale of 0 to 7 was 2.0, whereas for the susceptible check the mean was 4.3. The range in DI means for all company lines was 2.1 to 6.6. Mean percentage healthy roots (0 + 1 DI's) was 53% for FC 703 and 12% for GW 674-56C. The range in percentage healthy means for company lines was 0 to 52%. Mean percentage harvestable roots (DI's 0, 1, 2, and 3)

was 87% for FC 703 and 44% for GW 674-56C. The range in percentage harvestable roots for company lines was 19 to 89% (mean = 56%).

Breeding for Increased Resistance to Rhizoctonia Root Rot.--R. J. Hecker and E. G. Ruppel.

Sugarbeet production losses from rhizoctonia root rot continue to occur in a variable pattern. In certain areas and in certain years infection and losses seem to be much greater than in others. Reports, as well as our own observations, would indicate that losses due to rhizoctonia root rot were relatively severe in 1978. In a few isolated cases, rhizoctonia root rot has been the major factor for growers going out of the beet-growing business. It appears likely that certain beet production areas, which tend to have a chronic rhizoctonia problem, will require the incorporation of rhizoctonia resistance into the hybrid varieties used in those areas. This means that we need to continue the rather intense effort to further increase the resistance of germplasm made available to industry breeders, and to help develop information to make the incorporation and use of this resistant germplasm more efficient. However, the rate of breeding progress and the current levels of resistance in the best germplasms in our program indicate that we should arrive, in the foreseeable future, at a high level of resistance and then be able to reduce the rhizoctonia resistance breeding effort.

We currently use three breeding methods for the improvement of resistance, namely, recurrent selection, mass selection, and pedigree breeding (including inbreeding). We sometimes overlap the methods, or may switch breeding lines from one method to another depending on potential, resources, etc. At the same time we are doing some backcross incorporation of resistance into monogerm, type O, and cytoplasmic male sterile lines. Recurrent selection appears to have the greatest potential with respect to increasing resistance and maintaining desirable genetic characteristics including combining ability, which will make the resultant germplasm readily useful in commercial breeding programs. However, our resources are limited, hence, only a few of the most promising breeding lines can be included in the recurrent selection program. Less promising or newer breeding lines are carried in the mass selection program which requires considerably less resources.

Our most recent breeding developments, as well as various other materials of interest are evaluated each year in our inoculated rhizoctonia root rot nursery for the assessment of their resistance. Table 1 lists those multigerm lines of greatest interest in the 1978 tests. The most resistant line in this group was FC 705, a new line having been released during 1978. It is a Syn 4 developed from 4 cycles of recurrent selection in FC 701. The next 4 lines with disease indices of 1.4, and entry 592 with a DI of 1.5, are all relatively vigorous and should have potential as pollinators of experimental hybrids. Entry 571, with a DI of 1.5 is from the Fargo rot resistant line F1002, which was developed by Dr. Bugbee from FC 701/4. Other lines of interest are entries 567, 570, and 589 with DI's of 1.7, 1.8, and 2.3, respectively. These entries all have some potential as useful pollinators.

The most resistant entry of all is among the monogerm group in Table 2. Entry 577 (DI = 1.1) has been our most resistant line for the last 2 years.

Table 1. Rhizoctonia resistance of breeding and other lines (all multigerm) assessed by disease index (DI) and % healthy roots.

Entry no.	Population and description	DI Mean	DI % of check	% healthy
572	FC 705	1.3	76	66
593	FC 701/5 Mother-line selection	1.4	82	62
585	Syn 1 from misc Rhizoc resist. sources	1.4	82	58
551	Syn of progenies from GW 674 & C 817	1.4	82	60
545	FC 701/5; 8 cy resist. selection	1.4	82	60
592	FC 702/5 Mother-line selection	1.5	88	58
571	1 cy Rhizoc selection from F1002	1.5	88	60
553	Polycross & GH mass sels. from FC 703	1.5	88	58
594	FC 703 Mother-line selection	1.6	94	52
591	FC 707	1.6	94	58
590	Pool of progenies from GW 674 & C 817	1.6	94	56
552	Polycross selections from FC 701/5	1.6	94	58
612	FC 703; Rhizoc resist. check	1.7	100	53
567	Syn 2 from FC 801	1.7	100	53
564	Syn 2 from misc Rhizoc resist. sources	1.7	100	54
560	Syn 2 from FC 701/5	1.7	100	54
606	FC 701/2; Oregon increase	1.8	106	55
570	1 cy Rhizoc selection from EL-42	1.8	106	48
588	FC 701/4	1.9	112	50
587	Syn 1 from FC 801	1.9	112	52
586	FC 706	1.9	112	51
568	3rd cy sel. Rhizoc damp-off from FC 701/5, 702/5	1.9	112	49
546	Syn from FC 703	1.9	112	51
539	FC 704	1.9	112	48
622	64-7082; red root inbred	2.0	118	52
569	Rhizoc leaf spot & curly top resist. Syn	2.1	124	44
607	FC 702/2; Oregon increase	2.2	139	45
589	EL-42	2.3	135	44
556	Syn from Japanese lines	2.3	135	46
608	FC 701	2.4	141	42
544	F1001	2.6	153	42
555	Rhizoc sels. from Afanasiev rhizoc lines	3.1	182	34
609	FC 702	3.2	188	34
547	"Trench rot resist" USSR lines	3.7	218	25
557	Polish 203/71 (4X)	3.8	224	22
548	"Powdery mildew resist" USSR line	4.4	259	18
618	68-9535; red root inbred	5.1	300	10
	LSD (.05)	0.35		5.4

This line has resulted from selection in segregating generations of a cross between some of our rhizoctonia resistant multigerms and a pool of monogerm type O LSR-CTR lines. This population is segregating for monogerm; entry 573 (DI = 1.6) is a monogerm type O selection from this population, whereas entry 574 (DI = 1.6) is the first back-cross cytoplasmic male sterile (CMS) equivalent. In the process of selection and concentration of resistance in these materials, a significant amount of inbreeding has been done and these particular lines have reduced vigor and are agronomically unattractive due

to the long thin root shape and a tendency for the root to grow out of the ground. The release of some of these materials is anticipated in 1979. Even though they are not agronomically attractive, they are the most resistant germplasm in the world. Hence, they need to be made available to breeders as soon as possible.

Table 2. Rhizoctonia resistance of breeding lines which are monogerm or segregating for monogerm, and commercial type materials.

Entry no.	Population and description	DI Mean	DI % of check	% healthy
	Monogerm or segregating			
577	Syn 1 from Rhizoc resist X (mm,TO,LSR-CTR lines)	1.1	65	72
561	Syn 2 from Rhizoc resist X (mm,TO,LSR-CTR lines)	1.3	76	62
581	Syn 1 from Rhizoc resist SP 5831-0	1.3	76	61
575	Rhizoc resist monogerm; seg. for TO	1.3	76	64
550	Syn 1 from FC 701 X (mm,TO)	1.3	76	63
578	Sel. from FC 701 X (mm,TO)	1.5	88	63
563	Syn 2 from Rhizoc resist SP 5831-0	1.5	88	58
562	Syn 2 from FC 702 X (mm, TO)	1.5	88	56
576	Composite of S_1's from FC 701 X (mm,TO)	1.6	94	57
573	Rhizoc resist mm, type O	1.6	94	57
574	Rhizoc resist mm, CMS (B_1)	1.6	94	55
584	MS of Syn 1 from Rhizoc resist SP 5831-0	1.7	100	54
583	Sels from FC 701 X (mm,TO) F_2	2.2	129	41
582	Sels from FC 701 X (mm,TO) B_1P_2	2.4	141	40
565	Syn 2 from (mm,TO) X FC 701, B_1P_1	2.4	141	39
	Commercial-type materials			
589	EL-42	2.3	135	44
595	Mono Hy D2	3.5	206	25
610	Beta Poly 2 (Hungary)	3.7	218	20
611	Beta Poly 4 (Hungary)	3.8	224	22
558	Polish Mono-IHAR (4X)	3.8	224	20
597	Betaseed 1237	4.0	235	15
601	U-I Hybrid 68	4.2	247	16
596	HH 26	4.2	247	22
602	US H20	4.3	253	15
598	ACH 12	4.3	253	19
605	SP 7322-0	4.5	265	19
599	US H10B	4.6	271	8
604	C 813	4.8	282	15
600	AH-10	4.8	282	12
603	C 17	5.2	306	11
612	FC 703; Rhizoc resist check	1.7	100	53
	LSD (.05)	0.35		5.4

The commercial-type materials listed in Table 2 are included for relative assessments and comparisons. The most resistant line in this group, EL-42 (entry 589, DI = 2.3), resulted from a program of crossing and selection of Fort Collins rhizoctonia resistant material with East Lansing material by Dr. Hogaboam. The commercial varieties in this group can be classed as susceptible, although there are significant differences among those that are the least and the most susceptible. The pollinator C813 and C17 (entries 604 and 603) with DI's of 4.8 and 5.2, respectively, are among the most susceptible entries in the test which, undoubtedly, contributes to the high level of susceptibility of US H10B (entry 599, DI = 4.6), of which C17 is the multigerm pollinator.

Those lines included in Tables 1 and 2 were those of greatest interest among the total of 95 entries in the experiment. A number of the lines are relatively diverse and represent some new sources of resistance. In general, the breeding lines that remain in the program are those few which show some degree of response to selection pressure. Included in the program over the years were many lines which failed to respond and were dropped. From the number of lines that have been dropped, and especially from the hundreds of sources evaluated for resistance, it appears that most sugarbeet lines have essentially no genes for resistance to *Rhizoctonia*.

Observations and results from our selection and breeding program continue to re-enforce our hypothesis that resistance is multigenic. Also the resistance that we have developed would appear to be horizontal resistance, in that we know of no *Rhizoctonia* strain to which germplasm from the Fort Collins resistance breeding program has been found to be susceptible. The hypothesis of horizontal resistance in these materials gains credence as more people test our germplasms against their indigenous strains of *R. solani*.

Each year, we test some of our more promising multigerm lines as pollinators of experimental hybrids. The production of a number of these experimental hybrids is reported in another section of this report.

Performance of Rhizoctonia Resistant Experimental Hybrids and Pollinators.--
R. J. Hecker and G. A. Smith.

The rhizoctonia resistant multigerm lines coming out of our breeding program have several potential destinies; 1) direct use as a pollinator parent of a hybrid variety, 2) for crossing with other breeding lines and selection of high combining rhizoctonia resistant segregants, and 3) as a source of resistance for a backcrossing program. In order that our breeding developments have some potential for uses 1 and 2 we like to assess, preliminarily, their combining ability. Hence, we use a diverse group of CMS lines and pollinate them with different rhizoctonia resistant multigerm developments. The performance of the best individual hybrids in our 1978 disease-free test is shown in Table 1. None of these experimental hybrids were significantly better than the check. Three were not significantly different than the check for recoverable sucrose per acre, while all the others in Table 1 produced significantly less sucrose per acre. Some of these experimental hybrids could be of value in a growing area with a serious rhizoctonia root rot problem, even though they may be inferior to the check used in this disease-free experiment. Further description of these hybrids and even limited quantities of seed might be available for those who may be interested in testing them further.

Table 1. The best experimental hybrids in the 1978 test of hybrids involving rhizoctonia resistant pollinators.

Entry no.	Hybrid	Recov. sucrose (lbs/A)	Root yield (T/A)	Sucrose %	T.J. purity (%)
895	(652016s1 CMS X 662119s1) X FC 702/5	5360	22.8	14.6	90.2
836	(562 CMS X 546) X FC 703	5026	23.3	14.0	89.6
810	H65-02-69 CMS X FC 701/4 Phoma sel.	5026	21.2	14.6	90.6
889	(100363 CMS X 12166) X Syn misc. Rhiz. sources	5002	23.2	13.9	89.6
820	(562 CMS X 569) X FC 703	4931	22.8	14.0	88.9
841	KWS MS 63 X Syn of hetero mm, TO, LSR-CTR	4883	19.9	14.7	91.3
804	662119s1 CMS X FC 703 GH sels	4859	22.0	14.0	89.8
835	[(FC 504 CMS X FC 502/5) X 662119s1] X FC 701/5	4812	22.1	13.8	89.0
814	662119s1 CMS X FC 801 polycrossed sels	4812	21.5	14.3	90.1
853	KWS MS 63 X Syn from Japanese lines	4740	22.6	13.5	89.8
854	KWS MS 61 X Syn FC 703	4669	19.1	15.1	90.8
824	662119s1 CMS X Syn from C 817 & GW 674	4669	20.5	14.1	90.2
833	(562 CMS X 546) X FC 701/4 Phoma sel	4669	21.4	14.0	89.6
838	KWS MS 62 X Syn from Afanasiev lines	4669	20.4	14.2	89.7
830	(AI-1 MS X AI-2) X Syn of hetero mm, TO, LSR-CTR	4669	18.8	15.1	91.8
840	721055H01 CMS X FC 701/5 polycross sels.	4621	22.1	13.2	89.0
890	FC 603 CMS X Syn of FC 703	4621	19.6	14.7	89.8
	Mono Hy D2 (check)	5645	23.7	14.8	90.2
	LSD (.05)	636	2.7	0.8	1.3

An assessment of the general combining ability of the rhizoctonia resistant pollinators is made in Table 2. These are adjusted means from a partial diallel experiment conducted in a 10 X 10 triple lattice with 6 replications. Those pollinators that appear in Table 2 were those which were involved in three or more of the experimental hybrids in the test. Among this group of rhizoctonia resistant lines used as pollinators, FC 703 would appear to have the best general combining ability for recoverable sucrose and root yield. FC 703 has been released. It is relatively heterogeneous and has potential for further improvement of its combining ability. Also included in Table 2 is the disease index of these pollinators from a separate inoculated test in the rhizoctonia root rot nursery. All of the pollinators were relatively good for rhizoctonia resistance except the synthetic derived from Afanasiev resistant selections. The most rhizoctonia resistant pollinators may impart adequate resistance when hybridized with susceptible females so that the resulting hybrids could be used advantageously in rhizoctonia root rot problem areas.

Table 2. Adjusted means of all experimental hybrids of the respective rhizoctonia resistant pollinators (disease free), and disease indices in a separate inoculated test (0 = no rot; 7 = plants dead).

Pollinator	1978 Disease index of pollinator	Recov. sucrose (lbs/A)	Root yield (T/A)	Sucrose %	T.J. purity (%)
FC 703	1.7	4978	23.0	14.0	87.8
FC 701/4 Phoma resist. sel	1.5	4716	20.4	14.5	90.2
FC 701/5 Polycrossed sels	1.4	4454	20.0	14.1	89.7
FC 703 (4X)	1.8	4407	20.3	13.9	89.2
FC 801 Polycrossed sels	2.1	4359	19.4	13.9	90.1
Syn FC 703 GH sels	1.6	4240	18.9	14.3	89.6
Syn from Afanasiev resist. sels	3.1	4216	19.5	13.7	89.3
Syn from Japanese resist. sels	2.3	4216	21.6	12.8	88.6
Syn of hetero. mm, TO, LSR-CTR	1.5	4145	18.1	14.4	90.1
Syn of GW 674 & C 817 progenies	1.6	4121	18.9	13.9	89.3
Syn of SP 5831-0	2.0	4026	19.7	13.2	88.6
Mono Hy D2 (check)	3.5				

Rhizoctonia Inoculation and Resistance Selection in the Seed Production Phase.--R. J. Hecker and E. G. Ruppel.

A new method of additional exposure of sugarbeets to a root-rotting strain of *Rhizoctonia solani* was tested in 1977 and 1978. The method consisted of the placement of ground barley-grain inoculum around the mother roots when they were transplanted to the field for seed production. Hence, this method allows a second exposure to *Rhizoctonia* within a single generation.

Roots used in 1977 and 1978 had been grown the previous year, harvested about October 1, trimmed as mother roots, and stored over winter in our refrigerated root storage building at about 4-5 C and 100% relative humidity. The roots came through the winter storage periods virtually free of storage rot and deterioration.

As shown in Table 1, on April 27, 1977, we planted a line with intermediate resistance to *Rhizoctonia*, and a mix of rhizoctonia susceptible lines into a spacially isolated plot. For those plants that were inoculated, 0.4 or 0.8 g of inoculum was mixed into the top 5 cm of soil immediately around the root. The plants were watered immediately after planting. In 1978, two space isolations were used with 597 roots planted at one location, and 338 at the other. Rhizoctonia resistant breeding lines were used at these locations in an attempt to see if additional genetic progress could be made in lines that already were relatively resistant. Again, 0.4 g of inoculum was mixed into the top 5 cm of soil around each beet at planting time, and then the plants were thoroughly watered. The planting time was April 28 for the large isolation, and May 11 for the isolation with 338 roots.

The 1977 plot was considerably drier than that in 1978 because little, if any, precipitation was received in 1977.

In 1977, the plants in both the intermediately resistant line, and the susceptible lines succumbed very early to root rot and died; Table 1 shows the number of survivors on July 1. Since we had no interest in seed from the control plants, the plot was abandoned. In 1978 we decided to use the technique for selection in the two lines shown in Table 1. Since in 1977 there was no difference between 0.4 and 0.8 g of inoculum per plant, we used 0.4 g per plant in the 1978 isolations. By June 15, very little indication of infection was apparent, so a side dress of 0.4 g of inoculum per plant was applied by pulling the soil away from one side of the root to a depth of 5 cm, sprinkling the inoculum against the root, then replacing the soil and watering. However, one row in each isolation was left without this additional inoculation. In late June and early July, infection became abundant; however, some of the plants were flowering before infection became apparent. These plants were removed to eliminate their contribution to the pollen cloud. By harvest time (August 11), only those plants noted in Table 1 had survived, and essentially half of the survivors showed some sign of active rot in the roots. Seed was harvested in two groups, that from the rot-free roots, and that from those roots which showed some rot. The seed will be tested for resistance in the inoculated rhizoctonia nursery in 1979. At the time of seed harvest, there was no difference in survival between those rows that had been left without the additional side-dress inoculum and those that were reinoculated. Hence,

the initial inoculum at planting time was, undoubtedly, adequate. The 1978 plants became infected and succumbed to the infection much later than those in 1977. This may have been due to two reasons. The 1978 populations were considerably resistant, and moisture was much more abundant in 1978, due to over 15 cm of precipitation in May. Due to the rather late infection, the surviving plants, undoubtedly, received some pollination from plants that shed some pollen before they showed signs of infection.

Table 1. Surviving plants following Rhizoctonia inoculation of mother roots.

Population and year and treatment	Roots planted	Surviving plants: Some rot	Surviving plants: Rot free	Surviving plants: Total
1977				
Intermediate Rhizoctonia Resistant Line				
Control (no inoculum)	50			40
.8 g inoculum/plant	25			2
.4 g inoculum/plant	25			0
Mix of Rhizoctonia Susceptible Lines				
Control (no inoculum)	50			42
.8 g inoculum/plant	82			0
.4 g inoculum/plant	80			2
1978 (.4 g inoculum/plant)				
Rhizoctonia Resistant FC 703	597	11	16	27
Mix of Rhizoctonia Resistant Lines	338	8	6	14

Thus, the method did not result in a total elimination of genetic contribution by all infected plants; however, we believe the method provides significantly more selection pressure for resistance than a single exposure during vegetative growth. We believe the method might be used successfully with or without the roots having been inoculated in the vegetative stage. The two populations resulting from these intense selections will be tested and the results reported in 1979.

Effect of Cultivation Practice and Postemergence Herbicide on Intensity of Rhizoctonia Root Rot.--E. G. Ruppel and R. J. Hecker.

Observations have been made that forcing soil around and into sugarbeet crowns during cultivation and ditching operations may enhance rhizoctonia root rot infection. The objective of this study was to determine the real effect of this practice, and to determine how the cultural practices might be modified to reduce infection by *Rhizoctonia* without reducing the beneficial effects of the practice. In addition, the effect of a postemergence application of phenmedipham ('Betanal') and desmedipham ('Betanex') on root rot severity was investigated.

An area of our field nursery known to be heavily infested with *Rhizoctonia solani* in 1977 was selected for this study in 1978. Standard seedbed preparations were carried out, and cycloate ('Ro-Neet') at 3 lb active ingredient

(a.i.)/acre was broadcast and incorporated as a preplant herbicide 3 days before planting. Additionally, dry, ground, barley-grain inoculum of *R. solani* at 50 lb/acre was broadcast and incorporated to assure uniform dispersion of the pathogen across the experimental area. Manzate-treated sugarbeet seed of *Rhizoctonia*-resistant cultivar FC 703 and susceptible commercial cultivar Mono Hy Al were planted on April 7 in a 2 X 2 X 2 factorial design with four replications of each treatment-cultivar-herbicide combination. Four-row plots were 20 ft long with 22 inches between rows. On June 12, a 1:1 mixture of 'Betanal'-'Betanex' (B & B) at 0.5 lb a.i./acre was applied on a 7-inch band as a postemergence herbicide. Plots were thinned to 25 plants/row on June 14. Just before layby, a final cultivation and ditching operation was performed which deposited soil into and around the crowns of the beets in half the plots. Beets in the remaining plots were cultivated similarly except that the beets were shielded from soil.

Roots from all plots were harvested on September 11 and rated for amount of rot on a scale of 0 to 7, with 0 = no rot and 7 = plants dead. A disease index (DI), a weighted average based on the number of plants in each class, was calculated for each plot. Sugarbeets in classes 0, 1, 2, and 3 were considered to be "harvestable," because such roots ultimately would be processed in the sugar factory.

B & B had no significant effect on the incidence or severity of rhizoctonia root rot. Mean DI's were 4.3 with, and 4.2 without B & B across cultivars and cultivation (ditching) methods. Root rot was approximately twice as severe in the susceptible as compared with the resistant cultivar regardless of treatment.

A significant increase in root rot severity occurred in plots in which the cultivation practice deposited soil into and around beet crowns regardless of sugarbeet cultivar (Table 1). The increased rot led to a 6% reduction in harvestable roots of the resistant cultivar and a 20% reduction in the susceptible cultivar. Obviously, cultivation and ditching operations should be performed to minimize the deposition of soil into sugarbeet crowns. Slower tractor speeds, or planting on preshaped beds might serve this purpose.

Table 1. Effect of soil deposition in crowns of resistant and susceptible sugarbeet on severity of rhizoctonia root rot.

Cultivar	Hilling[1]	DI[2]	Harvestable[3]
			%
FC 703	+	2.9 a	72
(resistant)	-	2.3 b	78
Mono Hy Al	+	6.5 d	7
(susceptible)	-	5.2 c	27
C.V.		8.5%	

[1]Hilling = deposition of soil into crowns via cultivation practices.

[2]Disease index (DI) on a scale of 0 to 7, with 0 = no rot and 7 = plants dead. Means of eight replications; all significantly different at $P = 0.05$ according to Duncan's multiple range test.

[3]DI classes 0, 1, 2, and 3 combined.

Longevity of Rhizoctonia in Debris of Infected Rotation Crops.--E. G. Ruppel.

Plants of barley, bean, corn, and sorghum growing in pasteurized soil were inoculated with a root-rotting isolate of *Rhizoctonia solani* (R-9) from sugarbeet by replacing the top 2 cm of soil in each pot with soil mixed with dry, ground, barley-grain inoculum. After 30 days, plants were harvested and stem portions bearing typical *Rhizoctonia* lesions were excised, washed, and bulked from like species. The excised tissue was air dried, ground in a mill, and stored in a refrigerator at 3-4 C. At 1, 2, 4, and 8 months of storage, samples of "debris" from each crop were used to inoculate 2-month-old sugarbeets. Sugarbeet roots were harvested after 30 days and scored + or - for root rot. Isolations from rotted roots were made to identify *R. solani* as the causal agent.

No rot occurred in sugarbeet inoculated with any infested debris stored for 1 or 2 months (Table 1). Debris from sorghum only induced rot after 8-months storage, whereas infested debris from the other crops was infectious after 4 months. Thus, *R. solani* remained viable for 4 to 6 or 8 months in debris from infected rotation crops. Additional studies will be made to determine the effect of different storage conditions on the longevity of the pathogen within crop debris.

Table 1. Ability of stored *Rhizoctonia*-infected debris of rotation crops to induce root rot in sugarbeet.

Crop debris	Storage (months)				
	1	2	4	6	8
Barley	-	-	+	+	+
Bean	-	-	+	-	+
Corn	-	-	+	+	-
Sorghum	-	-	-	-	+

EPIDEMIOLOGICAL AND BIOLOGICAL INVESTIGATIONS ON FUSARIUM YELLOWS OF SUGARBEET (BSDF Project 54)

Cultural Comparisons of Fusarium Isolates.--E. G. Ruppel.

Isolates of *Fusarium oxysporum* f. sp. *betae* from Oregon, Wyoming, and Colorado significantly differ in cultural pigmentation, growth rate, and spore production; however, all isolates were morphologically similar.

Maintenance of Fusarium Stock Cultures.--E. G. Ruppel.

Fusarium species often lose pathogenicity when subjected to repeated subculturing on nutrient media. The pathogenicity of *Fusarium* from sugarbeet was maintained for at least 1 year in soil cultures. Approximately 3 g of a sandy loam soil was mixed with 0.1 g dry, ground barley grain and placed in a screw-cap vial. Enough water was added to just moisten the soil, and then

the vials were capped and autoclaved. When the vials were cool, a recent single-spore culture of *Fusarium* was used to infest the soil. The vials were loosely capped and incubated at room temperature. In 2-3 weeks, fungal growth was abundant and the soil had dried to the point of separation from the wall of the vials. At this time, the caps were tightened and the vials were placed in the refrigerator for storage.

REPORT ON POWDERY MILDEW
(Former BSDF Project 50)

Occurrence of Sexual Stage of Powdery Mildew in the U.S. is Confirmed.--
E. G. Ruppel.

D. L. Coyier, O. C. Maloy, and J. C. Zalewski reported finding the ascigerous (sexual) stage of the sugarbeet powdery mildew in 1974. Their paper, presented at the Pacific Division Meeting of the American Phytopathological Society in 1975, has been received with some skepticism since the ascigerous stage was not subsequently seen again for 2 years. More recently, R. L. Forster of the University of Idaho related (*personal communication*) that he also had found the ascigerous stage in April 1977 on buried sugarbeet debris of the 1976 crop.

Neither Coyier et al. nor Forster tested ascospores for their pathogenicity to sugarbeet. However, I have examined a powdery mildew-infected leaf provided by Coyier from Malloy's original collection and, indeed, did find typical *Erysiphe* cleistothecia of varied ages imbedded and attached to the surface mycelium. I have no doubt that these were structures of the sugarbeet powdery mildew and not chance contaminants from other plants.

The correct name of the *Erysiphe* from sugarbeet is still in question. Weltzien (Phytopathol. Z. 47:123-128, 1963) in Germany gave the fungus the species name *betae*. But Coyier et al. concluded that morphological differences between the sugarbeet mildew and *E. polygoni* were not sufficient to warrant a new species. They point out that there are many cases in the Erysiphaceae where similar or even greater differences exist without assignment of specific rank. Table 1 shows the morphological variability encountered among various investigators in studies of the beet mildew. According to Blumer (Blumer, S. 1933. Die Erysiphaceen Mitteleuropas mit besonderer Berücksichtigung der Schweiz. Zurich.), *E. polygoni* cleistothecia have a mean diameter of 112 µm, with 3 spores/ascus. Weltzien found equal numbers of 2- and 3-spored asci in the beet fungus, whereas I found 2-5, mostly 4, spores/ascus in the samples from England and France. Unfortunately, the cleistothecia found on the leaf provided by Coyier were not mature and did not contain asci with ascospores; however, a photograph of a cleistothecium made by Coyier showed at least 6 asci, each with 5-6 ascospores. Undoubtedly, more information is needed on the ascigerous stage of the U.S. isolates of *Erhsiphe* from sugarbeet before species classification can be made.

Most powdery mildews are heterothallic and require two compatible mating types for the completion of the ascigerous stage. The paucity of cleistothecia on

Table 1. Morphological data of the sexual stage of *Erysiphe* from sugarbeet.

Investigator	Source	Cleistothecia[1] Range	Cleistothecia[1] Mean	Asci[2]	Spores/ ascus[2]	Ascospores[2] L	Ascospores[2] W
		µm	µm			µm	µm
Weltzien	Lebanon	80-120	100	5.8	2.4	23.6	15.2
Drandarevski	Germany	95-120	102	4.4	3.1	24.2	15.2
Jensen	Denmark	85-126	100	4.8	3.4	26.0	16.0
Ruppel	England	71-117	94	-	4.0	23.7	11.8
Ruppel	France	67-117	94	-	4.0	25.4	11.8
Coyier	U.S.	72-106	87	-	-	-	-

[1]Diameters of cleistothecia.
[2]Means.

infected sugarbeet leaves from Washington (Coyier, Forster, *personal communication; personal observation*) is somewhat puzzling. Infected plants in Spain and England, and samples from England and France showed abundant and easily visible fruiting bodies over entire leaves. Conceivably, one of the necessary mating types of the sugarbeet *Erysiphe* occurs in extremely low frequency in the U.S., or it is less fit to compete in nature.

The occurrence of the ascigerous stage possibly can create a problem for breeders working toward resistance to the pathogen. The overwintering potential of ascospores is questionable, but the sexual stage would allow the formation of new fungal strains via genetic recombination.

CERCOSPORA/CURLY TOP RESISTANCE BREEDING RESEARCH AND LEAF SPOT EVALUATION (BSDF Project 25)

Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies.--
E. G. Ruppel and G. A. Smith.

Separate randomized complete block designs with two replications were used to evaluate a total of 157 breeding lines submitted by American Crystal, Great Western, Holly, and Spreckels Sugar companies. Internal checks included *Cercospora*-resistant cultivar FC (504 X 502/2) X SP 6322-0, a susceptible synthetic, and cultivar SP 5822-0 having intermediate resistance to *Cercospora*. The nursery was planted April 14 and inoculated July 10. The epidemic developed uniformly and reached maximum severity on or about August 29 when leaf spot evaluations were made on our usual 0-10 scale. Mean ratings for the resistant check ranged from 1.5-3.3 across all tests (overall mean = 2.5), whereas the susceptible check ranged from 6.5-7.3 (overall mean = 7.0). The intermediate check ranged from 3.0-3.5 (overall mean = 3.3). Company lines ranged from 3.3-7.0. Results of the individual tests were tabulated and sent to each respective contributor.

Breeding for Resistance to *Cercospora* and Curly Top Virus, 1978.--G. A. Smith and E. G. Ruppel.

The leaf spot epidemic in our 1978 nursery was uniform and moderately severe. The leaf spot and/or curly top ratings for some of our breeding lines and experimental hybrids are presented in Table 1. Curly top ratings were taken in the 1978 curly top nursery at Logan, Utah under a moderate epidemic. As a result of our efforts to breed for combined resistance to both *Cercospora* and curly top virus, FC 606 (entry 1539) and FC 606 CMS (entry 1521) were officially released. These two lines were equal to or better than the resistant checks for both diseases in tests spanning 4 years. FC 606 CMS has demonstrated greater resistance to *Cercospora* than FC 606 T.O. Both lines are vigorous, and were excellent seed producers in Oregon. Another promising monogerm line (entry 1523) has shown very high resistance to *Cercospora* (equal or better than US 201). We synthesized the type O of this line, and both the CMS and type O lines were sent to Oregon for seed increase. These lines may be released in 1979 if seed production is adequate. The vigor and good seed producing attributes of lines such as FC 606 and FC 607 provides the breeder with the option of using these lines in the production of single-cross commercial hybrids. It is particularly noteworthy that, if these lines are used in single-cross hybrids, the number of genes controlling resistance that are transferred from the original parental line to the hybrid theoretically will be double that transferred in a 3-way top-cross hybrid.

Table 1. Mean leaf spot and curly top ratings of some breeding lines tested at Fort Collins and/or Logan, Utah, 1978.

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1521	751102 HO2	(652016s1 CMS X 662119s1, T.O.) X FC 605, T.O.	3.3	3.5
1522	751102 HO3	(642027s1 CMS X 662119s1, T.O.) X FC 605, T.O.	2.9	
1523	751102 HO4	FC(504 X 502/2)CMS X FC 605, T.O.	2.6	4.5
1524	751102 HO5	FC 506 CMS X FC 605, T.O.	2.9	
1525	751105 HO2	(652016s1 CMS X 662119s1, T.O.) X FC 506, T.O.	3.1	
1526	751119 H3	FC 605 CMS X LSR inter crosses from B. maritima & B. vulgaris	3.3	
1527	751124 HO1	662119s1 CMS (B_4), mm, LSR-CTR	3.4	3.0
1528	751124 HO2	FC(504 X 502/2)CMS X 662119s1,T.O.,mm	3.0	
1529	761029 H2	[FC(504 X 502/2)CMS, mm X FC 605,T.O.] X 761016 H, MM, non-O	3.1	
1530	761029 H3	(FC 506 CMS X FC 605)X 761016 H, MM, non-O, LSR	3.0	
1531	761029 H4	FC 605 CMS X 761016 H, MM, non-O, LSR	2.9	3.5
1532	761030 H2	[FC(504 X 502/2)CMS X FC 605]X 761017, MM, non-O, LSR	3.3	

Table 1. Mean leaf spot and curly top ratings . . . . . (continued).

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1533	761030 H3	(FC 506 CMS X FC 605)X 761017, MM, non-O, LSR	3.5	
1534	761034 H3	[(652016s1 CMS X 662119s1,T.O.)X FC 605,T.O.]X 761034 H, MM, LSR	3.5	
1535	761036 HO3	FC 602CMS X 761036 HO, mm, from 662110s1, CTR-LSR	3.6	
1536	761036 HO5	FC 605 CMS X 761036 HO, mm, from 662110s1, CTR-LSR	3.3	3.0
1537	761036 HO7	FC 506 CMS X 761036 HO, mm, from 662110s1, CTR-LSR	3.0	
1538	761039 HO2	FC 605 CMS X [FC(504 X 502/2)X SP 6322-0]	3.0	
1539	771002 HO	662119s1, mm, T.O. X 652016s1, mm, T.O. X FC 605, mm, T.O.	3.3	4.0
1540	771058 HO4	(652016s1 CMS X 662119s1,T.O.) X FC 604, T.O.	3.4	2.5
1541	771060 H	FC 801, MM, RR	4.6	
1542	771060 H2	FC 605 CMS, mm X FC 801, MM	3.5	3.5
1543	771060 H3	662119s1 CMS, CTR, mm X FC 801, MM	4.4	4.0
1544	771060 H5	(642027s1 CMS X 662119s1,T.O.) X FC 801, MM	4.3	3.5
1545	771060 H6	(652016s1 CMS X 662119s1,T.O.) X FC 801, MM	4.4	4.0
1546	771081 HO2	(642027s1 CMS X 662119s1, T.O.) X L-36, mm, CTR	5.4	1.0
1547	771081 HO3	(652016s1 CMS X 662119s1, T.O.) X L-36, mm, CTR	5.5	1.5
Checks				
1518	671201 HO8	LSR ck., FC(504 X 502/2)X SP 6322-0	3.0	
1519	A63-5	Intermediate LSR ck., SP 5822-0	3.4	
1520	731083	LSS ck., Synthetic check	6.9	
	US 41			4.2
	US 33			5.8
	LSD .05		0.84	1.12

[1]Leaf spot and curly top ratings based on 0-10 scale with 0 = no symptoms and 10 = death for curly top or complete defoliation for leaf spot.

SUGARBEET QUALITY IMPROVEMENT RESEARCH (BSDF Project 53)

Evaluation of Reciprocal Triploid Commercial European Varieties.--G. A. Smith.

Several recent reports have indicated that triploids synthesized using tetraploid monogerm male steriles are more productive than triploids synthesized using diploid male steriles. Most of these reports have compared non-commercial experimental lines. In 1978 we tested two commercial European triploids (French origin) against 3 adapted U.S. varieties. It is not known whether the two triploids were reciprocal equivalents or unrelated reciprocal triploids. The test was conducted with 5 replications at the Colorado State University Agronomy Farm. Results of the test are presented in Table 1. No significant differences between the reciprocal triploids were found. However, both triploids out-yielded the diploids for root weight. Although sucrose was generally low in the test (likely due to excess nitrogen fertilizer), all three diploids showed significantly higher sucrose % than the triploids.

Table 1. Performance of two reciprocal triploids and 3 commercial diploids. The average performance of 5 replications.[1]

Entry	Root weight[2] kg/plot	Sucrose %	Purity %
Solimer; 3X(4 X ♀)	(19.9)35.2 ab	11.4 b	87.36 bc
Monomer; 3X(4 X ♂)	(20.6)36.5 a	11.1 b	86.84 c
Mono Hy D2; 2X	(15.9)28.2 d	13.1 a	88.98 ab
HH 26; 2X	(18.6)32.9 bc	13.1 a	88.80 ab
74MSH149; 2X	(18.1)32.1 c	13.2 a	89.72 a

[1]Means followed by the same letter are not significantly different ($P \leq 0.05$). Root wt C.V. = 6.2, sucrose % C.V. = 4.9, purity % C.V. = 1.5.
[2]Figures in parentheses are tons per acre.

Predicting Thin Juice Purity.--S. S. Martin, R. J. Hecker, and G. A. Smith.

There have been numerous attempts to assess sugarbeet "quality," defined in various ways by various authors. Burba (1975; ref. 5 in Table 1) has summarized many of these approaches. Ideally, quality embodies both chemical and physical properties of the sugarbeet, and often it is judged in relation to recoverable sucrose at a particular factory. Because not only the beets' characteristics but also the design and operating characteristics of the factory enter into consideration, a quality measure of this type must be individually developed for each situation. However, it often has been accepted that measurement of synthetic thin juice purity (TJPUR) by methods similar to those developed by Carruthers and Oldfield is an adequate (though imperfect) measure of sugarbeet "quality" at harvest. Prediction of TJPUR by means of chemical analyses of other components of various extracts also has been attempted by several authors. We have begun an investigation of TJPUR prediction, in which we plan to compare several published

Table 1. Comparison of purity prediction equations vs. measured laboratory thin juice purity in one experiment (n=80).

Ref.†	Purity prediction equation	Data units	R^2 with msrd TJPUR	Predicted TJPUR mean	Mean diff. (Pred.-Msrd.)	Paired t
1	TJPUR = 97.0 - 0.8(2.5K + 3.5NA + 10.0AMN)	g/100 g S	72	92.61	- 0.47	5.64**
2	TJPUR = 99.17 - 1.03(2.9K + 2.3NA + 10.0AMN)	"	70	94.59	+ 1.51	17.60**
3	TJPUR = 96.80 - 1.4K - 7.02NA - 7.51AMN	"	71	91.34	- 1.74	18.12**
4	TJPUR = 99.36 - 0.1427 (K + NA + AMN)	meq/100 g S	71	93.27	+ 0.19	2.25*
5	TJPUR = 97.4 - 0.10(K + NA + AMN)	"	71	93.13	+ 0.06	0.65 ns
6	TJPUR = 97.77 - 1.32K - 5.0NA - 7.07AMN	g/100 g S	73	93.28	+ 0.21	2.54*
7	TJPUR = 97.58 - 0.922(2.5K + 3.5NA + 10.0AMN)	"	72	92.52	- 0.56	6.75**
8	TJPUR = 97.83 - 2.00K - 4.25NA - 6.68AMN	"	74	93.08	(0)	0.04 ns
9	TJPUR = 97.95 - 2.36K - 3.94NA - 5.25AMN	"	75	93.08	(0)	0.02 ns

†[1]Carruthers, A., J. F. T. Oldfield, and H. J. Teague. Paper presented to 15th Tech. Conf., British Sugar Corp., 1962. (Original not seen; cited in Last and Draycott, reference 3 below.)
[2]Kearney, P. A. J. Sci. Fd. Agric. 22: 342-348 (1971).
[3]Last, P. J., and A. P. Draycott. Int. Sugar J. 79: 183-185 (1977).
[4]Wieninger, L., and N. Kubadinow. Zucker 24: 599-604 (1971).
[5]Burba, M. J. Am. Soc. Sugar Beet Technol. 18:360-377 (1975).
[6]Equation derived from different Ft. Collins experiments (N levels).
[7]Equation derived from different Ft. Collins experiments (experimental hybrids).
[8]Equation derived by multiple regression on data of this experiment.
[9]Equation derived by multiple regression on data of this experiment, but in Aluminum-clarified filtrate. (All other equations are calculated with lead-clarified filtrate data.)

prediction methods (models) with measured TJPUR data from experiments including different genotypes, years, nitrogen levels, population densities, and extracts. We also will derive for each experiment the best multiple regression prediction equation, and compare to this the performance of published models and of models derived by us for other experiments. An example of the approach will be illustrated here with data from a single experiment.

Summarized in the upper portion of Table 1 are five published TJPUR predictive equations and two unpublished equations derived from other Fort Collins experiments. Each of these is based on sodium (NA), potassium (K), and amino nitrogen (AMN) measurements in lead-clarified filtrate. Sodium and potassium were determined by flame photometry with a lithium internal standard, and amino N was analyzed spectrophotometrically using ninhydrin. Equations 8 and 9 of Table 1 are the standards for comparison, derived by multiple regression from data of the same experiment, the first in lead-clarified filtrate (the data used in all the predictors above) and the second in aluminum-clarified filtrate. Actual laboratory thin juice purity was determined on the 80 samples of this experiment, and each predictive equation or purity model was compared for its ability to predict the measured purity of each sample.

Thin juice purities predicted by equation 8 were highly correlated with corresponding measured thin juice purities ($r = 0.86$). About 74% of the variability in measured thin juice puirty can be accounted for by the relationship given; the inclusion of betaine in the equation increased R^2 by only 0.5. A more complex multiple regression equation derived from the same experiment but including eight variables (Na, K, amino N, total N, nitrate, chloride, betaine, and sucrose) increased R^2 to only 76.

Other subsets of chemical components may predict purity nearly as well as sodium, potassium, and amino N. For example, in this experiment nitrate was the variable accounting individually for the greatest proportion of variation in measured purity ($R^2 = 56$). A predictive model based on nitrate, amino N, and sodium gave $R^2 = 72$, almost as high as that of equation 8, and amino N and sodium together (excluding potassium) also showed $R^2 = 72$.

Although the coefficients differed, a purity model based on Na, K, and amino N in aluminum-clarified filtrates was as satisfactory as the equivalent model for lead-clarified filtrates (equations 9 and 8, respectively, in Table 1).

Although all of the seven thin juice purity models derived from data of other experiments predicted purities that were well correlated with measured purities in this experiment, most consistently either over- or under-predicted the actual values. Only equation 5 accurately predicted the actual thin juice purity mean, and predicted purity values that did not differ significantly by paired-sample t-test from measured purities. However, it is probable that yet another set of data will be best fit by a different one of the seven models. In further work we will explore the effect of several agronomic variables on these purity models, and the potential for a broadly applicable purity model.

Comparison of Aluminum Chloride and Lead Subacetate Clarification of Sugarbeet Brei Extracts. III. Analysis of Diverse Experimental Material.--
S. S. Martin and R. J. Hecker.

Lead-clarified and aluminum-clarified filtrates were compared in an experiment that included four sugarbeet cultivars (from a low-sucrose, low-purity type to a high-sucrose type) and two levels of nitrogen fertility. Analytical methods were described in Sugarbeet Research, 1977 Report. Although data analysis is not yet completed, preliminary comparisons of means and correlations coefficients between the two extract types are summarized in Table 1.

Table 1. Comparison of chemical constituents in aluminum- vs. lead-clarified sugarbeet extracts. [n-288]

Extract component	Correl. coeff. r	--------Component concentration[1]------ Lead-clarified Mean	s.e.	Aluminum-clarified Mean	s.e.
Sucrose	0.99	14.73	0.12	14.70	0.13
Sodium	0.97	10.1	0.24	10.0	0.24
Potassium	0.95	21.2	0.32	20.5	0.32
Amino nitrogen	0.88	5.8	0.09	6.4	0.09
Total nitrogen	0.67	23.	0.20	21.	0.18
Nitrate	0.96	12.7	0.49	17.1	0.56
Betaine	0.22	161.	1.4	36.	0.23

[1]Means are in mg/100 ml of extract except pol sucrose in percentage of sugarbeet root fresh weight. Amino N and total N expressed as N, and nitrate as NO_3^-.

These data do not differ greatly from a previously reported preliminary experiment (Sugarbeet Research, 1976 and 1977 Reports). Pol sucrose means of the two filtrates were almost identical, the correlation coefficient was above 0.99, and a paired-sample t-test showed no significant difference between filtrates. Sodium and potassium also were similar in means and had high correlation coefficients. Amino nitrogen was somewhat higher in aluminum-clarified filtrates than in the lead-clarified ones. As we have shown in another report in this volume, a purity predictive equation based on sodium, potassium, and amino N determined in aluminum-clarified filtrate is equally as effective as a similar equation using data from lead-clarified filtrate.

Because of interference to the nitrate specific ion electrode by the chloride salt used in this experiment, the apparent nitrate values in aluminum-clarified filtrates were erroneously high, but the correlation coefficient with nitrate determined in lead-clarified filtrates was high. Thus, as in the previously reported test, it appears that a nearly linear error of 35% overestimation exists because of chloride interference, and that an appropriate transformation of nitrate data in aluminum-clarified filtrates would yield results nearly identical to the data in lead-clarified filtrates. Although total nitrogen analysis in either of these extracts probably is meaningless, there was a moderate degree of association between the data. Only for betaine were data in the two filtrates not comparable.

WEED CONTROL IN SUGARBEET

Progress Report on Genotype - Herbicide Interaction Study; (BSDF Project 25).--G. A. Smith and E. E. Schweizer.

In the 1977 "Bluebook Report" page C17-18, we reported the initiation of a study to determine if genotype X herbicide interactions are a factor with use of several common pre- and post-plant herbicide treatments in sugarbeet. We tested five commercial varieties, five inbred lines, and five F_1 hybrids under three different herbicide regimes. In one of the sequential treatments, Ro-Neet was applied preplant at 3 lb/A followed by a mixture of Betanal (1/2 lb/A) and Betanex (1/2 lb/A) applied post-emergence. In the second sequential treatment, Nortron was applied at 2 lb/A followed by a mixture of Betanal and Betanex. A check consisting of all 15 entries was grown without herbicide treatment.

Data reported here is from 1978 which provided optimal moisture conditions for herbicide action.

For root yield numerous interactions were found among the 15 entries across the 3 herbicide regimes. Of most interest was the interaction of the 5 commercial cultivars with the herbicide treatments. Table 1 presents the rankings for root yield. Two of the cultivars (ACH 12, GW A_4) ranked relatively the same regardless of herbicide treatment, whereas HH 26 and Mono Hy D2 performed differently across the herbicide treatments. Beta 1237 yielded relatively poor under herbicide treatment but ranked near the top when compared under the hand weeded checks. Nortron reduced the root yield of the 5 commercial cultivars an average of 11 percent compared to the no weed competition check. Ro-Neet reduced root yield 4% compared to the check.

Interactions of F_1 hybrids and inbred lines with the herbicide regimes was much greater than for the commercial cultivars and reduction in yield compared to the hand weeded checks also were much greater.

Herbicide treatments caused slight reductions in sucrose % for inbreds, F_1 hybrids and commercial varieties.

Table 1. The relative ranking[1] for root yields of 5 commercial varieties under 3 herbicide regimes at Fort Collins, 1978.

Variety	Ro-Neet B & B	Nortron B & B	Check (no herbicides)
Mono Hy D2	2	3	4
Am Crys 12	5	5	5
Holly HH 26	3	2	3
GW A_4	1	1	1
Beta 1237	4	4	2

[1] 1 = highest yield, 5 = poorest yield.

Control of Broadleaf Weeds in Sugarbeets with Glyphosate (Roundup); (BSDF Project 55).--E. E. Schweizer.

In the USA, growers can control 75 to 95% of their annual weeds in sugarbeets with herbicides, but this level of control is still unsatisfactory if we are to produce sugarbeets from the "tractor seat." Researchers have shown that a low number of weeds will compete with the crop and reduce yields. For example, root yields were reduced 8% by four kochia plants, 16% by twelve redroot pigweed plants, and 35% by twelve (equal densities) common lambsquarters, kochia, and redroot pigweed plants per 100 feet of row. At the latter density we found that 1.5 lb/A of Roundup, applied with a recirculating sprayer in 1977, reduced weed competition in sugarbeets to the extent that root yields were increased 7.9 tons per acre over where no Roundup was applied. Further, in Colorado, our best sequential herbicide treatments (preplanting plus postemergence) have had only 2 to 11 broadleaf weeds per 100 feet of row at harvest. Based on our results in 1977, we felt that the use of recirculating sprayers, or a modification thereof, may be the breakthrough that we need in the USA to control weed escapes from the "tractor seat."

The objectives of this study were to determine the effectiveness of glyphosate to reduce the competitiveness of a low density of kochia, common lambsquarters, and redroot pigweed in sugarbeets; and to determine the effect of glyphosate on sugarbeet root yields, percentage sucrose, and gross sucrose.

Materials and Methods. Diclofop (Hoelon) was applied at 1.5 lb/A on April 4 to control grass species. This herbicide was applied broadcast and incorporated with a Lilliston rolling cultivator at 4.5 mph. Pelleted Mono Hy D2 seed were planted on the same day at a spacing of one seed per 4 inches of row. Within two days after planting, an equal population of common lambsquarters, kochia, and redroot pigweed was established at a density of 12 plants per 100 feet of row. On May 15 we had to replant the sugarbeets. The sugarbeets were thinned on June 14 to a spacing of one plant every 10 to 12 inches.

The soil texture was a clay loam, with 2.5% organic matter, and a pH of 7.7. A randomized complete block design with four replicates was used. The plot size was 4 rows by 50 feet.

Commencing on July 3, the height of each weed was recorded in treatments 2, 5, and 7, and then thereafter every 4 weeks. In treatments 1 and 4, the height of each weed was recorded on July 19, and then thereafter every 4 weeks. On September 19, all broadleaf weeds from the center of each 2 rows were weighed separately by species.

On July 3, a recirculating sprayer was used to spray weeds above the sugarbeet canopy in treatments 2 and 5. The mean height (inches) of each species was: sugarbeets - 14, common lambsquarters - 20, kochia - 22, and redroot pigweed - 12. The lowest tip was 18 inches above the ground and the highest tip was 27 inches above the ground.

The sprayer was calibrated to apply 20 gpa on a broadcast basis and glyphosate was applied through four straight stream nozzles. Glyphosate

was applied once or twice at 1.5 and 2.25 lb/A (see Table 1 for specific treatments). Pressure was 13 psi and the ground speed was 3 mph. On July 3, wind was 0 to 5 mph at a height of 40 cm and the ambient temperature was 78 F. On July 17 the second application was applied to treatments 2, 3, 5, and 6. There was no wind and the average temperature was 83 F. On July 19 treatments 1 and 4, which received only one application of glyphosate, were treated. At this time the average height (inches) of sugarbeets was 18, common lambsquarters 41, kochia 39, and redroot pigweed 25 cm. The lowest stream nozzle was 22 above the ground.

On July 3, the total number of sugarbeets present in each plot was counted. On July 31, the total number of injured sugarbeets was counted. From this data the percentage of injured sugarbeets was calculated.

Sugarbeet roots were harvested from the inner two rows on October 13. The roots were counted, washed, weighed, and analyzed for sucrose content.

Results. Weed control. The effect of glyphosate on the three broadleaf weeds was not as effective as that observed in 1977. The principal reason being that the sugarbeets had to be replanted and the growth of the broadleaf weeds were set back because of cold, wet weather and from the mechanical disturbances caused by the planter. Glyphosate affected the average height and weight of these three weed species more than actually killing them (Table 1). Weed kill *per se* was minimal, and this was undoubtedly due to the fact that most weeds were just not tall enough to intercept enough glyphosate when it was applied.

Sugarbeet tolerance. The number of injured sugarbeet plants is shown in Table 2. Based on our visual observations, we found that 3 to 4% of the sugarbeet plants appeared to be injured even in the untreated weedy and weed-free plots. We are not sure why this occurred because we did not actually spray across the top of the sugarbeet plants in these plots; however, a drop of glyphosate could have occasionally fallen from a nozzle onto these plants as the sprayer was driven through the plots. Further, we observed that the 2.25 lb/A rate did not injure anymore plants than did the 1.5 lb/A rate, irrespective of whether the herbicide was applied once or twice. However, a few more sugarbeet plants were injured where we applied glyphosate only once instead of twice. We believe this occurred because where we applied the herbicide only once, we delayed the application until June 19 and the average height of the weeds was greater, thus we probably had additional splattering of the herbicide onto some sugarbeet plants underneath these larger weeds.

The effect of glyphosate on the yield parameters is summarized in Table 2. Glyphosate did not significantly affect percentage sucrose or number of harvestable roots. Further, glyphosate did not affect any yield parameter when applied at either 1.5 or 2.25 lb/A over the top of sugarbeets where no weeds were present.

Yield of both roots and gross sucrose was low because the sugarbeets had to be replanted. Even so, the competition of the density of 12 weeds per 100 feet of row reduced root yield and sucrose yield significantly in the untreated weedy-check plot. Since glyphosate did not completely control the weeds and injured sugarbeet plants initially, both root and sucrose yields were significantly less than the untreated weed-free controls.

Summary. Common lambsquarters, kochia, and redroot pigweed were not controlled satisfactorily by glyphosate. The principal reason being that the growth rate of these weeds was slower than what we normally have observed in previous years where we did not have to replant sugarbeets. We feel that because we had to replant the sugarbeets and because the growing conditions were atypical early in the year, we were not able to satisfactorily evaluate the efficacy of glyphosate rates and number of applications in this study. Therefore, we plan to redesign the herbicide sprayer for 1979 and repeat this experiment.

Table 1. Effectiveness of glyphosate treatments to reduce the height and weight of three broadleaf weeds[a,b]

Trt. no.	Treatments	Rate (lb/A)	No. of applications	Common lambsquarters			Kochia			Redroot pigweed		
				No./A	Ht (cm)	Wt (gm)	No./A	Ht (cm)	Wt (gm)	No./A	Ht (cm)	Wt (gm)
1	Glyphosate	1.50	1	1056	95	125b	1056	80	152b	66	42	6c
2	Glyphosate	1.50	2	792	60	93b	858	67	177b	594	62	219bc
4	Glyphosate	2.25	1	1056	100	106b	990	66	146b	198	73	238bc
5	Glyphosate	2.25	2	858	57	74b	792	60	181b	330	60	294b
7	Untreated (weedy)	0.00	0	1122	115	353a	1056	134	997a	726	103	645a

[a]All weed heights measured 8 weeks after the initial application of glyphosate. Treatments 2, 5, and 7 were measured on August 28 and Treatments 1 and 4 on September 13. Weeds harvested on September 19.

[b]Means followed by the same letter within each column do not differ significantly at the 5% level of probability a determined by Duncan's multiple range test.

Table 2. Effectiveness of glyphosate treatments to reduce the competitiveness of three broadleaf weeds in sugarbeets, 1978.

Trt. no.	Treatments	Rate (lb/A)	No. of applications	Weed density[a]	Root yield (T/A)	Sucrose (%)	Sucrose (lb/A)	Number of roots[a]	Injured sugarbeet plants (%)
1	Glyphosate	1.50	1	12	11.0	17.6	3840	106	19
2	Glyphosate	1.50	2	12	12.4	17.5	4310	104	16
3	Glyphosate	1.50	2	0	13.1	17.8	4670	107	6
4	Glyphosate	2.25	1	12	11.4	17.2	3920	107	23
5	Glyphosate	2.25	2	12	12.0	17.6	4240	108	15
6	Glyphosate	2.25	2	0	14.0	18.0	5030	109	6
7	Untreated (weedy)	0	0	12	12.3	18.0	4420	110	3
8	Untreated (weed-free)	0	0	0	14.3	18.0	5130	110	4
	LSD (0.05)				1.6	0.6	540	6	
	C. V. (%)				8.8	2.3	8.2	3.9	
	F-test				**	N.S.	**	N.S.	

[a]Number of weeds or roots per 100 feet of row.

SUGARBEET RESEARCH

1978 Report

Section D

North Dakota Agricultural Experiment Station, Fargo, North Dakota

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Cooperation:

American Crystal Sugar Company
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
North Dakota Agricultural Experiment Station
Sugarbeet Research and Education Board of
Minnesota and North Dakota

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CONTENTS

STORAGE ROT RESEARCH - 1978

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Two newly recognized storage pathogens in the Red River Valley

Storage rot was severe in some districts during the 1976-77 campaign. This probably was due to frost damaged roots and a crop grown under drought conditions. An unusual amount of Botrytis cinerea, an important storage rot fungus, was seen in the piles. There also was an abundance of mold, which appeared to consist of two different fungi. Rotted roots were studied in the laboratory. Penicillium cyclopium and Penicillium funiculosum were identified from these roots as members of the storage rot pathogen population. This is the first report of P. funiculosum as a sugarbeet pathogen. Both species were as virulent as Penicillium claviforme and more virulent than Phoma betae or Botrytis cinerea on two germplasms (F1001 and F1002) that were developed for resistance to P. betae and B. cinerea. They were less virulent on a breeding line (PBP4) that was selected for combined resistance to P. betae, B. cinerea, and P. claviforme (Table 1).

Table 1. Rot in root tissue from three sugarbeet germplasms (F1001, F1002, and PBP4) and one commercial cultivar (American Crystal 2 hybrid B, "2B"), caused by Phoma betae, Botrytis cinerea, Penicillium cyclopium, Penicillium funiculosum, and Penicillium claviforme.

Pathogen	Rot rating[a] in host of given genotype			
	F1001	F1002	PBP4	2B
P. betae	0.8	1.1	1.4	3.4
B. cinerea	1.8	1.6	2.6	4.8
P. cyclopium	3.5	3.0	2.0	4.8
P. funiculosum	3.4	2.9	1.9	4.9
P. claviforme	3.0	2.8	2.0	4.8

LSD = 0.9

p = 0.01

a/ Rot rating indicates the distance rot progressed through a 1-cm^2 block of root tissue after 2 weeks' incubation at 20° C: 0, 0 mm; 1 = not over 2 mm; 2 = over 2 but not over 4 mm; 3 = over 4 but not over 6 mm; 4 = over 6 but not over 8 mm; 5 = over 8 and up to 10 mm (entire block).

Pleospora bjoerlingii in the U. S.

Pleospora bjoerlingii is the perfect or sexual stage of the important sugarbeet pathogen, Phoma betae. The sexual stage has never been cultured and has been described three times in nature. All reports are from Europe.

Pleospora bjoerlingii, developed on seedstalks of sugarbeet after inoculation of the flowering plants with conidia of Phoma betae following harvest, and exposure of the seedstalks outdoors in Fargo. Single ascospore isolates were more virulent than a standard Phoma isolate on genotypes that had been developed for storage-rot resistance. The Pleospora stage was found on sugarbeet seedstalk stubble from each of seven fields that were sampled in the Salem, Oregon area where most of the domestic seed is produced.

The ability to produce the sexual stage on seedstalks will enable us to gain basic information about the mating cycle and inheritance of important characteristics. Production of this stage in culture in the laboratory would accelerate this work. Experiments are now in progress to accomplish this.

Sugarbeet seedling disease caused by Phoma betae on storage rot resistant genotypes

Sugarbeet genotypes possessing resistance to storage rot caused by Phoma betae were more resistant than a commercial cultivar to seedling disease caused by P. betae when inoculated seeds were grown in sand at 25C. Resistance was expressed as greater stand counts, greater plant fresh weights, less blackleg symptom, and a lower frequency of reisolation compared to the commercial cultivar. The amount of seedling disease caused by a set of isolates of the pathogen under controlled environment, showed variation in virulence among the isolates. An isolate that caused the most storage rot also caused the most seedling disease.

The results of some tests have not been duplicated. This failure may be due to uncontrolled relative humidity in the growing environment. Humidity has an affect on seedling disease development. A repeat of these tests in new growth chambers with controlled humidity will be done soon. Until then, conclusions from this experiment are that: resistant reactions in the seedling phase to P. betae do not indicate conclusively that a resistant storage rot reaction will be associated with the same material.

The data does show, however, that seedling disease resistance against P. betae is available so attempts to develop these genotypes should proceed because in some parts of the world, especially Europe, seedling disease caused by Phoma is much more important than storage rot.

The effect of plant age, storage, moisture, and genotype on storage rot evaluation of sugarbeet

Research since 1971 showed that evaluation of sugarbeet roots for storage rot resistance could be measured after roots were stored for at least 80 days at 5C. After storage, tissue cylinders are removed with a cork borer and placed on pure cultures of the test pathogens. Two germplasms with storage rot resistance were developed using this method. The availability of seed of resistant genotypes permitted a comparison with a susceptible genotype

regarding the effect of root maturity and storage environment on the response to major storage pathogens. The major objective of this study was to learn how to evaluate roots faster.

When sugarbeets were grown in 1976 under moisture stress, they became more resistant to rot caused by Phoma betae and Botrytis cinerea, but more susceptible to these fungi plus Penicillium claviforme when moisture was adequate. However, when aged roots of a susceptible commercial cultivar were stored at 5C for 80 days, those grown under adequate moisture in the fall of 1977 suffered less rot than those grown under moisture stress. It was concluded that: 1) 80-day-old roots could be evaluated for resistance to P. betae and B. cinerea in dry or wet years and to P. claviforme in wet years; and 2) differences between susceptible and resistant reactions will be as good or better than other storage regimes when roots are stored 30 days at 5C. This method shortens the growing period by 80 days and the storage period by 50 days and would be useful in identifying resistant roots in a breeding program from which new resistant lines are desired. Rot ratings, when averaged over root age and storage treatments, showed roots of a greenhouse-grown resistant genotype to be superior to a susceptible commercial cultivar. Thus, roots for evaluation may be grown in the greenhouse as well as in the field.

This shortened method requires 124 days compared to 254 days for the previous method. There are five advantages of evaluating 80-day-old roots: 1) less storage space will be required by the smaller roots; 2) sugarbeet roots must be vernalized for 80-120 days to induce flowering. The shortened method affords ample time to select, vernalize and obtain seed in the greenhouse before the next growing season; 3) two cycles of testing and seed production could be accomplished annually in the greenhouse; 4) storage rot information could be obtained from young, induced roots (stecklings) prior to seed production; and 5) a nursery could provide storage rot information before harvest of the main plots.

The effect of root dehydration on the storage performance of a sugarbeet genotype resistant to storage rot

Moisture loss from sugarbeet roots because of drought during the growing season or because of exposure to drying conditions after harvest causes the roots to become more susceptible to storage rot. Results from the USSR further show that cultivars resistant to storage rot maintain a higher leaf and root turgor than susceptible roots under drought conditions. Our objective was to determine the effect of water loss from stored roots on rot caused by the major storage pathogens in this region and to see if genetic resistance to rot would reduce sucrose losses under moisture stress.

The sugarbeet cultivar American Crystal 2 hybrid B (2B) was superior to the storage-rot resistant genotype 75P6 in the production of recoverable white sugar per ton (RWST) at harvest, but 75P6 was superior to 2B after the roots had been inoculated with Phoma betae, Botrytis cinerea, and Penicillium claviforme and stored at 10C in 98% relative humidity for 106 days. The amount

of rot in 75P6 was 50% of that in 2B when roots had lost 8-10% of their weight in storage. Dehydrated roots had a lower clear juice purity (CJP) and RWST than turgid roots. Severely dehydrated roots (24% weight loss) of both genotypes did not develop more rot than turgid roots (9% weight loss), but there was a decrease in pol sucrose, CJP, and RWST.

The quality deterioration of dehydrated roots during storage reported here, agrees with others, but our results show these losses may not be accompanied by increased rot.

Dehydrated and infected roots of 75P6 did not suffer an increase in rot over the turgid roots. In fact, there was no change in rot development within each genotype whether dehydrated or turgid. There was a significant decrease during storage in RWST, purity, and pol sucrose in dehydrated infected 75P6. It is possible that moisture loss, coupled with infected tissue, caused a sufficient increase in respiration in 75P6 to account for the decrease in sucrose content. There is a general phenomenon that infected, resistant plant tissue respires at a higher rate than infected, susceptible tissue. Therefore, the prevention of root dehydration during storage was more important for the rot-resistant genotype than it was for the susceptible cultivar.

SUGARBEET STORAGE - 1978

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Sugarbeet storage is a complex problem which will require changes in several areas to reduce losses to a minimum. The major loss of sucrose is caused by respiration, followed by microbial and biochemical changes such as raffinose synthesis.

Mechanical damage is a significant factor in the losses that occur by respiration. Mechanical damage to the beets occurs at several points during the harvest cycle, e.g., scalping, lifting, loading, unloading, and cleaning by the pilers. If mechanical damage is reduced, then part of the respiration losses would be prevented. The damage inflicted by scalping could be eliminated by removing only the leaves and petioles (flailing) and not cutting the crowns. Numerous reports have shown that flailing would reduce storage losses by decreasing respiration and by reducing storage rot.

The purpose of scalping is to remove tissue which has a higher concentration of impurities and lower sugar compared to the main body of the root. Data from Sidney, Montana, by Dr. A. D. Halvorsen showed that the amount of sugar extracted from crown tissue can represent over 20% of the total produced per acre depending upon the rate of nitrogen. Data presented by personnel of The Great Western Sugar Company have indicated that flailing reduces storage losses and recoverable sugar per acre is increased by flailing.

The objectives of this study were to determine the amount of crown delivered to the factories and its effect on quality. In 1975 and 1976 samples were obtained at several piler locations in the valley. In 1977 and 1978 samples were obtained at the Moorhead factory. Also, in 1978 samples were obtained at the Wahpeton factory. Two tare samples were obtained with the automatic sampler on the piler from each load. One sample from each load was used to determine the weight of the crown material above the lowest leaf scar that was delivered to the piler by the grower, and to determine the quality of the sample after complete crown removal. The remaining sample was used to measure quality of the roots as delivered. In 1975 and 1976 the samples were analyzed at the East Grand Forks Laboratory. The 1977 and 1978 samples were analyzed at the USDA Laboratory located at NDSU.

The data indicate that over 20% of the material delivered to the factory is crown tissue (Table 1). Percent sugar was not affected by complete crown removal in 1975, 1976, or 1977. In 1978, a significant change in percent sugar was noted at both Moorhead and Wahpeton when all of the crown material was removed. However, complete crown removal did not affect purity or recoverable white sugar per ton (RWST) at Moorhead in 1977 or 1978, but a significant change was noted at Wahpeton in 1978.

Table 1. Effect of complete crown removal on sugar, purity and recoverable white sugar per ton (RWST) over a 4-year period

	1975	1976	1977	1978	
				Moorhead	Wahpeton
Number of samples	89	270	50	50	50
Percent crown removed	20.5	20.8	20.8	23.3	23.4
		Sugar, %			
Control	16.0	17.0	15.6	16.2	15.4
Topped	16.2	17.1	15.9	16.7*	16.0*
		Purity, %			
Control	-	-	94.1	92.5	90.7
Topped	-	-	94.3	92.8	91.7*
		RWST, lbs			
Control	-	-	274	276	251
Topped	-	-	281	286	267*

* Significantly different from control.

These data indicate that complete crown removal (over 20% of the material delivered to the factories) does not consistently affect quality. Data reported in the 1975 Sugarbeet Research and Extension Report showed that growers were removing 20% of the crown tissue produced by scalping. A survey was conducted at the Moorhead factory in 1977 to determine the size of the cut surface of the crown. Over 1,000 roots were selected from the "picking table" and measured over a 2 hour period. The data indicated that the average size cut was 2.4 inches. Use of the regression equation reported in the 1976 Sugarbeet Research and Extension Report to predict the amount of crown removed based upon the size of the cut surface showed that 20% of the crown had been removed by scalping.

The primary purpose of scalping is to reduce the impurity load in the factory. The data presented here and by others has showed that scalping probably does not substantially reduce the impurity load. However, all research has showed that scalping increases respiration and rot losses. In view of these two facts, a serious question can be asked about the validity of scalping.

A test was conducted with a grower in 1978 to determine the effect of flailing vs scalping of sugarbeets on yield and quality. A uniform field of 168 rows, 0.5 mile in length, was divided into three sections. Section 1 contained 56 rows defoliated and scalped by the grower using a 3-drum defoliator. Section 2 contained 64 rows defoliated with a 2-drum defoliator which went over the rows in two directions. Section 3 contained 48 rows defoliated and scalped the same as section 1. Each section was harvested with a 4-row harvester. Nine loads were obtained from section 1 and was delivered and sampled by the routine company procedure. Two loads for sugar, two for tare, and five not sampled. Sugar and tare samples were taken alternately from the 10 loads obtained from section 2 and 8 loads from section 3. The samples were analyzed by the normal procedure at the East Grand Forks Laboratory.

The data showed that there was no effect on yield or quality when the beets were flailed compared to scalped (Table 2).

Table 2. Quality and yield of flailed and scalped sugarbeets from a commercial field in 1978

	n	Sugar %	Nitrate	Conductivity	Tare %	Yield Gross T/A	Yield Net T/A	Gross Sugar T/A
Flailed	5	16.82±.42*	4.2±.4	5.2±.5	3.8±.3	20.74	19.96	3.36
Scalped	6	16.42±.24	4.0±.4	4.5±.2	3.7±.4	20.99	20.23	3.32

* Standard error of mean, yield based on total tonnage of all loads delivered from each section of field.

Another experiment was initiated in 1978 to determine the change in RWST of flailed and scalped roots during storage. Roots of two commercial cultivars (approximately 5 tons of each cultivar) were obtained from a grower. The beets were defoliated with a 2-drum defoliator which went over the rows in two directions, lifted with a 6-row lifter into a beet cart, dumped into a small truck and transported to the laboratory. The roots of each cultivar were harvested separately. The roots were washed and three levels of topping were completed in the laboratory by hand with a knife. The topping treatments were: 1) no crown removed; 2) a 1-1.5 inch; 3) a 2-2.5 inch cut through the crown. The roots were inoculated with a spore suspension of 3 common storage pathogens and placed into perforated plastic bags. The bags were divided into two groups. Group 1 was stored at a constant 5 C (41 F) and group 2 was stored at 15 C (59 F) for 20 days, at 10 C (50 F) for 20 days and then at 5 C for the remainder of the storage period. The storage period will be 160 days. At 60 days after harvest a set of samples from each temperature regime were frozen at -18 C (0 F).

There were no significant differences in quality at harvest among the topping levels (Table 3). Cultivar 2 was significantly better than cultivar 1 for sugar, purity and RWST. This data supports previous conclusions that the crown tissue removed by scalping does not reduce the impurity load of the factories.

There were no significant effects due to topping level after a 40-day storage period within each temperature regime. However, the roots stored at the higher temperature lost more RWST than those at 5 C. The roots stored at 5 C lost 7.3 and 6.0% of RWST for cultivars 1 and 2, respectively. The roots stored at the higher temperature regime lost 15.4 and 16.7% for cultivars 1 and 2, respectively. These data indicate the importance of cooling the beets soon after piling. The benefit of lower respiration and less rot in flailed roots will become more apparent after a longer storage period.

Table 3. Effect of cultivar and topping level on quality at harvest and after a 40-day storage period averaged over two storage temperature regimes

Cultivar	Topping level	Harvest Sugar %	Harvest purity %	Harvest RWST lbs	40-Day Storage Sugar %	40-Day Storage Purity %	40-Day Storage RWST lbs
1	none	14.4	93.3	248	13.4	91.6	222
	1"	14.4	93.3	248	13.0	91.7	217
	2"	14.2	93.3	245	13.3	91.4	219
	complete†	14.4	93.3	248	-	-	-
2	none	16.2	93.9	283	14.9	92.7	254
	1"	16.0	93.7	278	14.8	92.3	250
	2"	16.0	93.8	279	14.6	92.0	245
	complete	16.3	94.7	289	-	-	-
c.v.,%		3.8	0.8	4.9	4.1	1.0	5.5

† A set of samples were topped to the lowest leaf scar at harvest. Crown tissue accounted for 26.7 and 25.0% for cultivar 1 and 2, respectively.

Growth Regulators on Sugarbeets

Yield and sucrose content of sugarbeet, Beta vulgaris L., are negatively correlated. Post-harvest losses of sucrose have increased because of longer storage periods. The objectives of this study were to determine the effect of growth regulators on yield and sucrose content at harvest and on post-harvest losses of sucrose. Gibberellic acid and maleic hydrazide were tested for 3 years. A cytokinin hormone and a leaf inhibitor were tested for 2 years. None of the compounds increased yield or sucrose content at harvest. Gibberellic acid significantly reduced sucrose content and increased impurities at harvest each year. Gibberellic acid increased the post-harvest respiration rates during storage at 5C and near 100% relative humidity. Maleic hydrazide reduced post-harvest respiration rates in one test. Neither the cytokinin hormone, or leaf inhibitor had any effect on post-harvest respiration rates. These data confirm that of other researchers in that none of the chemical compounds tested have consistently increased yield or sucrose content at harvest or reduced post-harvest storage losses.

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SUGARBEET RESEARCH

1978 Report

Section E

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CONTENTS

Evaluation of Sugarbeet Hybrids

G. J. Hogaboam

The evaluation program in 1978 was cooperative with the Farmers & Manufacturers Beet Sugar Association and its member companies.

The sugar and purity analyses were conducted by M. G. Frakes, and Paul Pfenninger, Michigan Sugar Company. The percent sucrose, percent clear juice purity, and recoverable white sugar per ton were determined according to "A rapid and practical method of determining extractable white sugar, as may be applied to the evaluation of agronomic practices and grower deliveries in the sugarbeet industry", by S. T. Dexter, M. G. Frakes, and F. W. Snyder, as published in the Journal of the American Society of Sugar Beet Technologists.

Thirty-two hybrids, US H20 (as 2 entries), and US H21 were tested at the Saginaw Valley Bean-Beet Research Farm at Saginaw, Michigan. These results are reported as experiment 7.

Experiment 7. USDA Nursery Hybrid Trial, B & B Farm, Saginaw, Michigan (1978)

CMS	O	Pollen	RWS/A	Tons/A	RWS/T	% Sucrose	% CJP	Beets /100'
SP74566-01	x SP74550-0	x SP6822-0	5425	20.00	271.0	16.16	94.16	71
SP74566-01	x SP74550-0	x EL40	5545	18.93	292.7	17.15	94.98	78
SP74564-01	x SP74550-0	x SP6822-0	5308	18.46	288.1	16.97	94.73	69
SP74564-01	x SP74550-0	x EL40	5770	19.38	298.6	17.49	94.95	84
FC506ms	x SP7042-0	x SP6822-0	5253	18.25	287.6	17.04	94.38	76
FC506ms	x SP7042-0	x EL40	4851	16.53	293.2	17.28	94.64	73
SP74550-01	x SP7042-0	x SP6822-0	5326	19.23	276.7	16.48	94.18	71
SP74550-01	x SP7042-0	x EL40	5117	16.79	305.5	17.98	94.63	75
SP73557-01	x SP7042-0	x SP6822-0	5841	20.31	287.1	16.88	94.79	68
SL129ms	x UI12161P	x SP6822-0 (US H20)	5888	20.66	284.7	16.73	94.86	79
SP73557-01	x SP7042-0	x EL40	5259	17.81	295.6	17.37	94.77	75
SP74564-01	x SP7042-0	x SP6822-0	5388	19.31	278.4	16.58	94.15	71
SP74564-01	x SP7042-0	x EL40	5721	19.42	294.3	17.39	94.46	70
SP74565-01	x SP7042-0	x SP6822-0	5555	19.92	279.8	16.62	94.31	70
SP74565-01	x SP7042-0	x EL40	5155	17.80	287.4	16.99	94.49	76
SP74566-01	x SP7042-0	x SP6822-0	5191	18.13	285.9	16.94	94.40	77
SP74566-01	x SP7042-0	x EL40	5769	19.76	291.6	17.18	94.66	74
SP74572-03	x SP7042-0	x SP6822-0	5599	19.52	285.8	17.01	94.14	78
SP74572-03	x SP7042-0	x EL40	5488	19.16	286.1	16.99	93.95	70
UI11866	x UI12166	x SP6822-0 (US H20)	5268	18.49	284.6	16.78	94.67	73
UI12161ms	x SP7042-0	x SP6822-0	5273	18.48	285.0	16.86	94.49	70
UI12161ms	x SP7042-0	x EL40	5155	17.42	297.2	17.50	94.66	69
Salinas 546H3		x SP6822-0	4920	17.82	275.6	16.43	94.17	69
Salinas 546H3		x EL40	5423	18.95	286.2	16.86	94.70	75
Salinas 1718H54		x SP6822-0	5745	21.31	269.2	16.05	94.18	75
Salinas 1718H54		x EL40	5716	20.82	274.2	16.46	93.74	72
Salinas 1718H5		x SP6822-0	5426	20.26	268.6	16.05	94.08	73
Salinas 1718H5		x EL40	5732	19.83	289.1	17.01	94.77	78
SP70557-01	x EL36	x EL40	5730	20.59	278.4	16.51	94.37	77
SP71550-01		x SP6822-0 (US H21)	4922	16.68	293.9	17.22	94.96	63

Experiment 7. (Continued)

CMS	O	Pollen	RWS/A	Tons/A	RWS/T	% Sucrose	% CJP	Beets /100'
SP74564-01	x EL36	x EL40	5972	20.97	284.9	16.88	94.40	77
SP74565-01	x EL36	x EL40	5873	21.10	278.3	16.53	94.34	75
SP74566-01	x EL36	x EL40	5877	20.84	281.5	16.73	94.27	71
SP74572-03	x EL36	x EL40	5693	21.15	269.7	16.17	93.87	66
UI12166	x EL36	x SP6822-0	6039	22.23	272.2	16.21	94.21	76
General Mean			5508	19.32	285.4	16.89	94.45	73
LSD 5%			NS	3.02	12.7	0.59	0.63	NS
CV %			14.24	13.71	3.91	3.07	0.59	14.07

SUGARBEET DISEASE INVESTIGATIONS IN 1978

C. L. Schneider and R. L. Sims

1. Test of fungicides for control of leaf spot disease (Cercospora beticola). Plots of commercial sugarbeet variety, US H20, each comprising one 5-m row, were planted on 18 May. Rows were 71.1 cm apart. Dried and ground sugarbeet leaves, infested with C. beticola were applied as inoculum to the foliage on 28 June. By 8 August, disease incidence was 100%. Commencing on 15 August, treatments were applied twice, - either on 14-day or 21-day schedule, - as foliage sprays with a hand-operated, CO_2- powered sprayer at 103.4k Pa and at the rate of 561 liters spray material/ha.

   Plots were rated according to disease severity on 7 and 25 September. Inasmuch as the disease had become established prior to the first spray application, satisfactory disease control required eradicative as well as protective capability in a treatment. There were significant differences among treatments (Table 1). The following reduced disease intensity significantly below that of the untreated control: BayKWG09925W + ATplus 411F; Benlate 50W; BTS40542 25EC; Difolatan 4F; DPX 112-2 80W; DPX 164-2 74W; Mertect 340 F; Mertect 266 S; Orthocide 50W.

2. Screening test of fungicides for root rot control (Rhizoctonia solani). Single-row plots of commercial variety sugarbeet variety, US H20, each 5-m in length and spaced at 71.12 cm, were planted on 18 May. On 29 June, 14 treatments were applied as sprays in a 20.3 cm band along the plant rows with a CO_2-powered, hand-operated sprayer at the rate of 561 l of spray material/ha and at 103.4k Pa (15 psi). On 30 June, dried barley-grain inoculum of R. solani was applied mechanically along the plant rows and into the leaf whorls. Disease incidence and intensity were determined for each plot on 7 August and 13 October and expressed as percent root rot.

   By 7 August, there were significant differences in percent root rot between most of the treatments and the untreated control (Table 2). By 13 October, there were also significant differences among treatments. Treatments most effective in reducing root rot included Bravo, DPX 164-2, Du-ter, and Terraclor.

3. Test of fungicides for root rot control (Rhizoctonia solani). Plots of commercial sugarbeet variety, US H20, each comprising two 10-m rows, were planted on 18 May at two locations. The preceeding crops at Locations I and II were sorghum and sugarbeet respectively. Fungicide treatments were applied on 29 June with a pair of modified tractor-mounted herbicide-type band-spray units. Each unit was provided with two hollow cone nozzles angled at 45° and two side shields 15.24 cm apart. Sprays were applied in a band along the plant row at the rate of 561 l of spray material/ha and at 103.4 k Pa (15 psi). Dried barley grain inoculum of R. solani was applied mechanically along the plant rows and into the leaf whorls on 30 June. By mid-July, symptoms of root rot were evident. On 11 August and at harvest time mean percent root rot in each plot was determined.

   By 11 August, with extremely high disease intensity in untreated plots at

both locations, there were significant differences in root rot among treatments. At Location I, Benlate, Bravo, and Du-ter treatments consistently showed significantly less rot than the untreated control. At Location II, Bravo and Du-ter reduced root rot initially, but by harvest time none of the treatments were effective.

4. 1978 Seed Treatment Tests.[1/]
In certain years, some seed lots produced in Oregon are heavily infected with the fungus, Phoma betae. Six fungicides were tested for efficacy in reducing Phoma seed infection. Most treatments were combined with Dexon fungicide, commonly used to control seedling damping off caused by black root disease fungi. Two seed lots of commercial variety US H20 were used: Lot A, produced in Oregon, with considerable Phoma infection and Lot B, produced in Arizona, with virtually none. The seed was treated with an aqueous slurry of each material. The following tests were then conducted: 1) a plating-out test of Lot A on water agar to determine degree of Phoma infection; 2) a seed germination test in sand; 3) a field test.

The plate-out test showed differences in Phoma infection among treatments (Table 1). The following reduced infection significantly below that of the control: Dexon + Captan, Dexon + BTS 40-542, Dexon + Terracoat, Dexon + Terraclor, Terracoat, Terracoat + Benlate. In the sand test, excellent germination occurred with all treatments as well as with the control. In Lot A, all treatments reduced seedling blight below the level of the control. Seedling blight in Lot B was considerably less than in Lot A. In the field test there was no difference in seedling emergence among treatments and between the two seed lots. Lack of Phoma damage is attributed to relatively warm temperature prevailing after planting, and negligible damage caused by soil damping-off fungi is attributed to dry soil conditions that prevailed. No phytotoxicity was evident with any of the treatments. Further testing of seed after one and two years storage is planned.

5. Effect of cropping sequence on Rhizoctonia crown rot.
This research was conducted at the Saginaw Valley Bean and Beet Research Farm in cooperation with D. R. Christenson, Michigan State University, Department of Crop and Soil Sciences. The experiment comprises four cropping sequences, two with 2-, 3- and 4-year rotations and two with 3- and 4-year rotations. Pre-harvest count of plants showing Rhizoctonia crown rot symptoms was made on 2 October.

Post thinning stands averaged 129 plants/100 ft of row with no significant differences among treatments. Rhizoctonia damage was evident as early as mid-June. Incidence of crown rot (av. 8.6%) was considerably higher than in any year since the experiment began in 1972. As the following table shows, crown rot incidence following corn was considerably less than following beans.

1/ Conducted in cooperation with R. C. Zielke, Farmers and Manufacturers Beet Sugar Association.

Cropping sequence no. and rotation period[1/]	Pct. crown rot[2/]
1. C-SB	3.5 a
C-C-SB	3.5 a
C-C-C-SB	1.4 a
2. C-B-SB	12.7 ab
C-C-B-SB	10.6 ab
3. B-SB	18.9 b
B-B-SB	10.1 ab
C-B-B-SB	6.5 ab
4. O-B-SB	18.8 b
O-A-B-SB	0.2 a

1/ A = alfalfa; B = navy beans; C = corn; O = oats; SB = sugarbeet.

2/ Treatments followed by some small letter do not differ significantly at the 5% level according to the LSD test. Results expressed as means of four 4-row plots, 66 ft long.

Table 1. Results of 1978 test of fungicides to control Cercospora beticola leafspot of sugarbeet, East Lansing, Michigan.

Treatment	Product rate/ ha	Product rate/ acre	Schedule (days)	Disease intensity index[1/2/] 7 Sept	Disease intensity index[1/2/] 25 Sept
Actidione 0.225%	1.26 kg	1.12 lb	14	3.8 ef	4.3 fg
Actidione 0.45%	1.26 kg	1.12 lb	14	3.5 def	4.3 fg
Actidione 0.90%	1.26 kg	1.12 lb	14	3.0 bcdef	4.0 efg
Bay KWG 0599 25 W[3/]	0.56 kg	0.5 lb	21	2.3 abcdef	3.3 bcde
Bay KWG 0599 25 W[3/]	2.24 kg	2.00 lb	21	2.0 abc	2.5 ab
Benlate 50 W	0.42 kg	6 oz	21	2.0 abc	2.8 abc
Benlate 50 W	0.56 kg	8 oz	21	1.5 a	2.5 ab
Benlate 50 W[4/]	0.45 kg	6 oz	21	1.8 ab	2.8 abc
Bravo 6 F	1.75 l	1.5 pints	14	3.5 def	4.3 fg
BTS 40 542 25 EC	2.22 l	30.4 oz	14	1.8 ab	3.0 abcd
BTS 40 542 25 EC	3.33 l	45.6 oz	14	2.3 abcd	3.0 abcd
BTS 40 542 25 EC	4.44 l	60.8 oz	14	1.5 a	3.5 cdef
BTS 40 542 25 WP	2.24 kg	2 lb	14	3.5 def	3.8 defg
BTS 40 542 25 WP	3.36 kg	3 lb	14	3.3 cdef	4.0 efg
BTS 40 542 25 WP	4.48 kg	4 lb	14	3.0 bcdef	3.8 defg
Cit Cop 4 E	4.68 l	0.5 gal	14	4.0 f	4.5 g
Difolatan 4 F	4.68 l	0.5 gal	14	2.5 abcde	3.5 cdef
Difolatan 4 F + Orthocide 50 W	4.68 l+8.97 kg	0.5 gal	14	2.0 abc	3.0 abcd
DPX 112-2 80 W	1.68 kg	1.5 lb	21	2.0 abc	3.3 bcde
DPX 164-2 74 W	1.68 kg	1.5 lb	21	1.8 ab	2.8 abc
DPX 164-2 74 W	2.80 kg	2.5 lb	21	1.5 a	2.3 a
Mertect 340 F	0.88 l	12 oz	21	2.0 abc	3.3 bcde
Mertect 26.6 S	0.88 l	12 oz	21	2.0 abc	3.3 bcde
Mertect 26.6 S	1.75 l	24 oz	21	2.3 abcd	3.8 defg
Orthocide 50 W	8.97 kg	8 lb	14	2.8 abcdef	3.5 cdef
Control				3.8 ef	4.3 fg

1/ Index = 0 (no disease) -9 (complete defoliation).
2/ Means of 4 plots values with same letters in the same column do not differ significantly at the 5% level according to Duncan's Multiple Range Test.
3/ Spreader-sticker (Atplus 411 F) added at 1.3 ml/liter.
4/ Antitranspirant concentrate (Vapor Gard) added at 4.2 ml/l.

Table 2. Results of screening test of fungicides to control Rhizoctonia root rot, East Lansing, MI, 1978.

Treatment and rate	/ha	/acre	Percent root rot[1/] 7 Aug.	13 Oct.
Benlate 50 W	0.56 kg	8 oz	31.4 ab	62.4 cdef
Benlate 50 W	0.84 kg	12 oz	26.3 a	53.1 bcd
Bravo 6 F	2.92 l	2.5 pints	27.4 ab	38.6 a
DPX 112-2 80 W	2.24 kg	2 lb	30.0 ab	64.4 defg
DPX 164-2 74 W	2.24 kg	2 lb	30.1 ab	49.4 abc
Du-ter 47.5 W	0.70 kg	10 oz	26.0 a	39.7 ab
Mertect 340 F	0.84 kg	12 oz	69.0 c	82.3 h
Mertect 20-S	0.84 kg	12 oz	44.1 b	65.4 defg
Mertect 20-S	1.68 kg	24 oz	41.4 ab	68.3 efgh
Terraclor 75 W	1.46 kg	1.3 lb	29.0 ab	59.3 bcdef
Terraclor 75 W	3.02 kg	2.7 lb	29.4 ab	50.3 abc
Vitavax 75 W	3.02 kg	2.7 lb	38.6 ab	69.4 fgh
Vitavax 75 W	5.94 kg	5.3 lb	29.7 ab	53.7 bcde
Untreated control			62.8 c	79.0 gh

1/ Mean of 7 plots, each comprising one 5-m row. Values with the same letter in the same column do not differ significantly at the 5% level according to Duncan's Multiple Range Test.

Table 3. Results of test of fungicides to control Rhizoctonia root rot, East Lansing, MI, 1978.

Treatment and rate	/ha	/acre	Percent root rot			
			Location I		Location II	
			11 Aug.[1/3/]	13 Oct.[1/3/]	11 Aug.[2/3/]	25 Sept.[2/3/]
Benlate 50 W	0.56 kg	8 oz	41.3 b	67.3 b	69.6 b	96.0 a
Bravo 6 F	2.34 l	2 pints	22.7 a	54.0 ab	31.0 a	89.4 a
Du-Ter 47.5 W	0.70 kg	10 oz	16.0 a	43.6 a	32.0 a	85.8 a
Terraclor 75 W	3.02 kg	2.7 lb	-	-	72.0 b	96.2 a
Untreated control			59.3 c	84.4 c	81.2 b	99.2 a

1/ Means of 3 plots, each comprising two 10-m rows.

2/ Means of 5 plots, each comprising two 10-m rows.

3/ Values with the same letter in the same column do not differ at the 5% level according to Duncan's Multiple Range Test.

Table 4. The effect of various fungicide seed treatments on *Phoma betae* seed infection and sand box germination of two seed lots of sugarbeet cultivar US H20.

Treatment and rate (oz/cwt)	Pct. Phoma[1/] infection	Sandbox test:[2/] Pct. seedlings blighted/emerged	
	Lot A	Lot A	Lot B
Dexon 70W, 3.5	22	28/96	2/98
Dexon 70W+Captan 75W, 3.5+12.0	11**	30/96	2/98
Dexon 70W+Benlate 50W, 3.5+1.6	29	28/96	6/98
Dexon 70W+Benlate 50W, 3.5+3.2	19	38/98	2/100
Dexon 70W+BTS40-542 25W, 3.5+4.0	0**	16/96	6/98
Dexon 70W+Terracoat SD205, 3.5+12.0	6**	24/100	2/96
Dexon 70W+Terraclor 75W, 2.0+2.0	13*	40/98	4/98
Terracoat SD205, 12.0	4**	56/96	6/100
Terracoat SD205+Benlate 50W, 12.0+3.2	1**	50/98	8/100
Untreated control	30	84/94	12/100

1/ Results based on plating out 90 seed units on water agar. Treatments significantly below that of the control at the 5% and 1% levels, according to the t-test, are designated * and ** respectively.

2/ Results expressed as means of two plantings of 50 seeds each.

Abstracts of Papers Published in 1978

1. Schneider, C. L., R. L. Sims, and H. S. Potter. 1978. Report of 1976 tests of fungicides to control leaf spot, crown rot, and powdery mildew diseases of sugarbeet. In Fungicide and Nematicide Tests 33:65-66.

Efficacy of 21 fungicide treatments in controlling leaf spot (Cercospora beticola), 19 treatments in controlling crown rot (Rhizoctonia solani), and 26 treatments in controlling powdery mildew (Erysiphe polygoni) was determined in field trials with commercial sugarbeet cultivar, US H20. In each test, all treatments reduced disease severity significantly below that of the untreated control. The tests showed significant differences among treatments in control of leaf spot and powdery mildew. Extreme variability among treatments in the crown rot control test resulted in non-significant differences among treatments.

2. Schneider, C. L. 1978. Use of oospore inoculum of Aphanomyces cochlioides to initiate black root disease in sugarbeet seedlings. J. Am. Soc. Sugar Beet Technol. 20(1):55-62.

Methods for preparation and use of oospore inoculum to initiate experimental infection of sugarbeet seedlings with the beet water mold, Aphanomyces cochlioides, are described. Increased density of oospore inoculum produced increased severity of black root disease in seedlings. Oospore inoculum applied below the soil surface near seed level produced a more severe disease than did inoculum applied on the soil surface, and inoculum applied at planting produced a more severe disease than did inoculum applied 6 days later. Disease severity increased when the proportion of mineral components:peat in potting mixes was increased from 1:1 to 2:1 or more. Oospore inoculum usually remained infective after storage for more than 1 year at 4 or -9°C.

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Agricultural Research Center, Beltsville, Maryland, is directed toward varietal improvement of sugarbeets resistant to Aphanomyces black root and Cercospora leaf spot, important diseases in eastern United States.

Testing for Leaf Spot Resistance

A good leaf spot epidemic was obtained in the 1978 Beltsville Nursery. Results of this test are presented in Table 1.

TABLE 1. Results of leaf spot tests at Beltsville in 1978.

Expt. No.	Description	No. Lines Tested	Av. Leaf Spot Rating* Av. of Lines	USH20 Check	Exptl. Hybrid Check
1 & 11	Black Root and Leaf Spot Resistant MM lines from Beltsville	66	4.0	5.5	3.8
15	MM Cold Temp. Germination Selections	33	3.9	5.7	3.7
17 & 18	MM Powdery Mildew Selections	50	4.6	5.4	3.8
17	MM Growth Chamber Selections	16	4.5	5.3	4.0
3 & 5	MM lines from E. Lansing	96	4.4	5.4	---
13 & 14	MM Soil-Free lines	66	5.0	5.6	3.8
2	BRR-LSR mm lines from Beltsville	33	3.6	5.2	3.7
4	mm lines from E. Lansing	46	4.0	5.3	---

*0 = No spots; 10 = All leaves dead.

It appears that selecting multigerm lines for ability to germinate well and rapidly at cold temperatures did not affect their leaf spot resistance. On other hand, multigerm lines selected for resistance to powdery mildew or for large seedling taproot size in the growth chamber were not as resistant as comparable unselected black root and leaf spot resistant lines. The loss in one desirable characteristic (resistance to leaf spot in this case) as a res

of selecting for another trait is consistent with the experience of plant breeders working with various crops, and points out the necessity of continuing to maintain desirable characteristics when selections are made for new traits. The poor leaf spot resistance of multigerm lines from East Lansing is the result of the inclusion of Rhizoctonia resistant lines that weren't particularly leaf spot resistant. The soil-free multigerm lines from Beltsville are also poorer in resistance because they stem from garden beets that weren't leaf spot resistant. The present level of leaf spot resistance of these soil-free lines, however, is considerably better than it was several years ago when selection for leaf spot resistance in this type material was begun, and better than USH20.

Testing for Black Root Resistance

Black root resistance tests were conducted in the greenhouse in the winter of 1977-1978. Results of these tests are presented in Table 2.

TABLE 2. Results of black root tests at Beltsville in 1977-1978.

Description	Black Root Rating*			
	No. Lines Tested	Av. of Lines Tested	Resistant Check	Suscept. Check
MM progenies from Leaf Spot Selections	105	100	100	110
MM progenies from Black Root Selections	207	101	100	109
MM progenies from SP74409-7	135	99	100	111
Lines from a Commercial Company	16	121	100	124
1977 Ohio State Test Selection	8	106	100	110
1978 " " " "	10	114	100	129
Exptl. monogerm hybrids from Beltsville	19	104	100	120

*Minimum-Maximum possible ratings: About 78 to 132.
Low rating = high resistance to black root.

The severity of disease in these tests varies from experiment to experiment, but the ratings are calculated in relation to the degree of resistance of the resistant checks. However, when the susceptible check has a high numerical rating, the lines being tested have a higher than normal numerical rating. The last four groups in Table 2 were in separate experiments, whereas, the first three groups in Table 2 each encompassed several experiments. Hence, the items listed as lines from a commercial company, the 1978 Ohio State Test selection, and the experimental monogerm hybrids from Beltsville are probably a bit more resistant than the numerical rating indicates. In the lines from the commercial company there is

only a difference of "3" between their average rating and the susceptible check, hence they must be considered rather susceptible. On the other hand, the average of the eastern breeding lines (the first three items in the table) is about equal to the resistant check. The resistant check is much more resistant than USH20. The average resistance of USH20 in these tests is about 107 or 108. Under present field conditions, the yield losses caused by black root in our most resistant material is negligible. Just as in the case of leaf spot, it is necessary to continue testing for resistance to black root in order to eliminate somewhat susceptible lines which appear in the process of selecting for other traits.

New Monogerm O-Types

Twelve new monogerm apparent O-types were located in indexing progenies in the greenhouse in 1977-78. All except one appears to have enough leaf spot resistance to be commercially usable in hybrid combinations. They have not yet been tested for combining ability. Tests on the B & B Farm in Michigan of single-cross experimental hybrids of male-sterile lines of O-types from previous years indicate that the combining ability of these male-steriles is not particularly good. Only four produced within 10% as much sugar per acre as USH20. It is possible, however, that one or two of these might produce superior hybrids in 3-way crosses.

Selecting Seedlings for Increased Vigor in Growth Chambers

In the 1977 Sugarbeet Research Report, the results of growth chamber tests of experimental hybrids produced from pollinator lines selected in the growth chamber for seedling root size and high root weight to leaf weight ratio (TLWR) were presented. One of these, SP73514-01 X SP6822-0 GCS (growth chamber selected), was tested at Beltsville and at the B & B Farm, Michigan, in 1978. These results are presented in Tables 3 and 4.

TABLE 3. 1978 Beltsville nursery test results of experimental hybrid from growth chamber selection.

Variety	Root Yield	Raw-Juice		
		Sucrose	Apparent Purity	Gross Sugar
	T/A	%	%	Lbs.
SP53514-01 X SP6822-0 GCS	9.53	12.6	79.70	2401
SP53514-01 X SP6922-0	10.36	14.0	83.43	2901

Unfortunately, no hybrid seed of SP53514-01 X SP6822-0 was available for nursery testing. However, there should be little or no difference in the productivity of SP53514-01 X SP6822-0 and SP 53514-01 X SP6922-0. Statistical analyses of the 1978 nursery test data were not available at this writing, but it appears that the pollen fertile parent produced by growth chamber selections has no better and perhaps even poorer combining ability than the line SP6822-0, from which it was selected. This also would mean that the results of growth chamber tests of experimental hybrids might not agree with results of field tests.

TABLE 4. B & B nursery test results of experimental hybrid from growth chamber selection.

Variety	Root Yield T/A	Sucrose %	C.J. Purity %	Sugar/Ton Lbs.	Sugar/Acre Lbs.
SP53514-01 X SP6822-0 GCS	20.02	16.19	94.43	272.0	5433
SP43514-01 X SP6922-0	22.17	16.41	94.74	278.5	6152

TABLE 5. Growth chamber test results of experimental hybrids produced from growth chamber selections.

Hybrid No.	Female Parent Sel. No.	Female Parent Source Material	Female Parent Sel. Class	X	Male Parent Sel. No.	Male Parent Source Material	Male Parent Sel. Class	Rank Test #1* Rt. Wt.	Rank Test #1* Rt. Wt. Leaf Wt.	Rank Test #2* Rt. Wt.	Rank Test #2* Rt. Wt. Leaf Wt.
1	72	SP6922-0	I	X	C-3	SP7622-0	I	1	2	3	4
2	81	SP7622-0	II	X	72	SP6922-0	I	2	3	1	2
3	72	SP6922-0	I	X	93	SP7622-0	VII	3	1	2	1
4	72	SP6922-0	I	X	C1	SP7622-0	X	4	4	5	5
5a	72	SP6922-0	I	X	71	SP6922-0	II	5	5	-	-
5b	71	SP6922-0	II	X	72	SP6922-0	I	-	-	4	4

*Test #2 is a duplicate of Test #1 except that the reciprocal of the 5th hybrid in Test #1 was used in Test #2.

In another experiment, growth chamber selections were made among seedlings of SP6922-0 and SP7622-0 multigerm pollen fertile lines. Four classes of selections were made on the following basis:

Selection Class	Root Weight	$\frac{\text{Root Weight}}{\text{Leaf Weight}}$ (TLWR)
I	High	High
II	High	Low
VII	Average	High
X	Low	Average

Clones were made of every selected plant so that the plants could be crossed in bags in all combinations. Seed was not produced on all plants in the bags so that testing of hybrid combinations was restricted, and seed quantities limited testing to the growth chamber. Results of these growth chamber tests are presented in Table 5.

As can be observed from the table, there appears to be a relationship between seedling taproot size (actually, taproot + crown) and the taproot weight to leaf weight ratio (TLWR). The two tests, however, did not produce identical results. As might be expected, hybrid #4 involving a Class X selection (low root weight and only average TLWR) had rather small taproots and a rather poor TLWR. The poor performance of hybrid 5a and 5b (reciprocal hybrids) might be due to the fact that both had SP6922-0 as their source. The poorer performance of hybrid #1 in Test #2 as compared with its performance in Test #1 has no logical explanation other than chance occurrence of genetically vigorous individuals in Test #1 and genetically smaller individuals in Test #2. It should be noted that hybrid #3 had the best TLWR in both tests in spite of the fact that it ranked third and second, respectively, in root weight in the two tests. This might indicate that a Class VII selection with its average size root must have a genetically extremely small top in order to have a high TLWR. It may also be probable that under most field conditions (20,000 plants or more per acre), this hybrid (#3 in these tests) might outyield the others because of the greater photosynthetic efficiency of its leaves.

In conclusion, it may be said that the growth chamber selection method may be a means of improving sugarbeets genetically in root production, but that this might not necessarily result in higher yielding under field conditions.

Production of Soil-Free Sugarbeets

When the two experiments containing progenies of soil-free sugarbeets were harvested, the plot was relatively dry. For the most part, the roots were free from adhering soil, making selection difficult. The selected roots were so clean (probably less than one gram of soil per root) they were put in storage without washing. Of the 66 progenies in these two experiments, six were equal to USH20 in leaf spot tolerance, and the remainder were more resistant. Root weights were not taken in these plots, but estimates of root

yield were made. Ten progenies appeared to yield less than USH20, and eight appeared approximately equal to USH20 in root yield. The remaining 48 appeared to be better than USH20 (It must be remembered that USH20 is not particularly high yielding at Beltsville because of its susceptibility to leaf spot.) Sugar analyses and raw juice refractometer readings were made on the selected roots. Generally, both sugar precentages and percent of other solubles were quite low. This is due to the fact that this material stems from garden beet crosses, and material of this origin is notoriously low in % sucrose. A few individual roots, however, have a reasonable sugar content and are being saved for crossing with sugarbeets.

F_1 hybrids of crosses between selected soil-free beets (originating from garden beets) and smooth-rooted sugarbeets ("soil-free" selections containing no garden beet ancestory) were grown in the nursery in 1978. These hybrids were also reasonably free from adhering soil although not as clean as the roots described in the previous paragraph. Since they were just as clean or cleaner than smooth-rooted sugarbeets, and since crosses between soil-free beets and ordinary sugarbeets produce F_1 hybrids that have considerable adhering soil, it is reasonable to assume that genetic factors conditioning root types with a tendency to cling to soil have been largely eliminated from both smooth-rooted sugarbeets and from soil-free beets. The selected F_1 hybrids in the 1978 nursery were also slightly higher in sugar content and content of other solubles than were selected roots of soil-free beets. Hopefully, the F_2 population from these F_1 hybrids will contain individual segregates that are both extremely soil free and high enough in % sucrose to be usable.

Production of Homozygous Sugarbeet Lines

Completely homozygous plants can be produced by first obtaining haploid plants and subsequently doubling the number of chromosomes. One method of obtaining numerous haploid plants in certain species is to grow plantlets from anthers by sterile tissue culture techniques. We have been attempting to develop such techniques for sugarbeets. Within the last 14 months we have been able to obtain callus growth from flowers with anthers removed. From this callus we can promote the development of roots and development of plantlets. We have been able to transfer plantlets to pots containing soil and obtain normally appearing sugarbeet plants. The plants examined cytologically have thus far been diploid indicating that the original callus must have come from normal diploid somatic tissue. We have not yet discovered a medium which will cause callus or plantlets to grow from anthers. One medium has caused the anthers to enlarge to many times (perhaps 20 or more times) their normal size, and within the next year we hope to find a medium that will cause anther dyads to grow into haploid tissue. When this hurdle is cleared, we should be able to produce completely homozygous sugarbeet lines without difficulty. Such lines should be very useful as testors to determine more accurately the combining ability of potential parental lines of hybrid varieties. The production of haploids might also be a useful tool for eliminating lethal and deleterious genes.

Cold Temperature Seed Germination

A nursery planting was made in 1978 to determine if breeding lines selected for rapid emergence of seedlings at cold temperatures would emerge more rapidly in the field. Unfortunately, the weather turned warm at planting time and all lines emerged quite rapidly. There was no difference in speed of emergence between the selected lines and the unselected lines.